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ABSTRACT

In 10 papers by independent experts, this volume explores the trends in and prospects for research training in member nations of the Organization for Economic Cooperation and Development. "Problems and Prospects of Research Training in the 1990s" (Stuart Blume) looks at trends in national policy toward research training and issues of quality. "Research Training in Australia--Policy, Practice, and Directions in the 1990s" (Tim Turpin and Sue Curtis) covers current issues including quality, and postgraduate training. "Research Training in Canada" (Gilles Julien), reviews university degree structure, current status, training and the labor market, and current concerns and initiatives. "Research Training in Finland" (Ulla Ekberg), looks at the Finnish system, steering mechanisms for researcher training, recruiting, characteristics of training, cooperation with business and industry, postgraduate study, and women in training. "Research Training in Italy" (Sveva Avveduto) describes research training inside and outside the university setting. "Research Training in Japan" (Shinichi Yamamoto), details the structure of degrees and scale of training, current organization and content of training, and current problems and initiatives. "Postgraduate Research and Training in the United Kingdom" (Robert G. Burgess and others), explores development of training; current dimensions and structure; training in the sciences, social sciences, humanities, and financing; student motives and experience; the labor market and an institutional response. "Postgraduate Research Training in the United States" (Jules B. Lapidus and others), discusses degree and training structures, current organization and content of training, issues and concerns, and new initiatives. "Research Training in the Czech Republic" (Dana Tollingerova and others) reviews preparation for training, postgraduate studies, institutionalization and internationalization, legal conditions, and the current science policy of the government. An appended paper, "Research Training and Employment for Holders of Doctorates in France--The Activities of the Association Bernard Gregory (ABG)" (Jose Ezratty) describes the origin, operation and studies of the ABG, European initiatives, and the international mobility of French postdoctoral researchers. (Papers contain references.) (JB)

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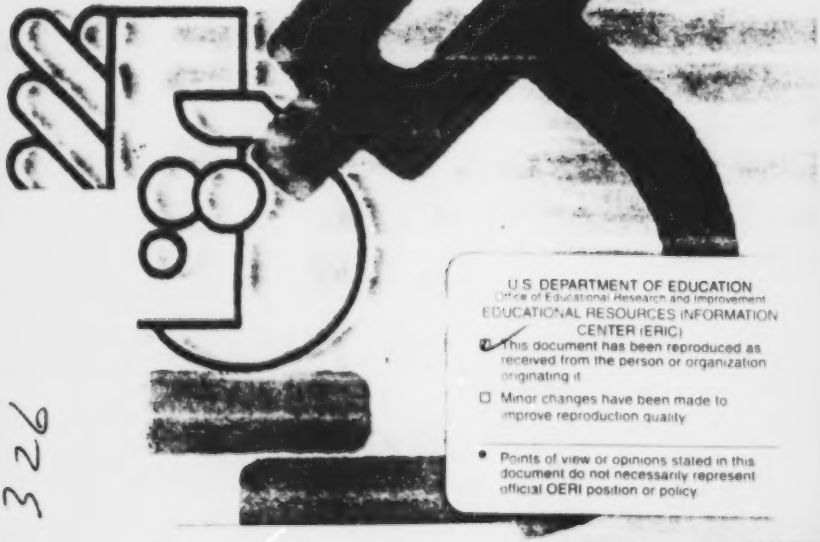

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FOREWORD

This publication reflects the growing interest of OECD governments in training through, as well as for, research. In 1990, the Dutch Minister for Education and Science, in co-operation with his German, Belgian and French counterparts, set up an International Consultative Committee under the Chairmanship of Professor de Wied to assess the situation and propose future directions. The report of the de Wied Committee was transmitted to the OECD Group on the Science System which agreed to further study this matter and extend the analysis to other countries.

For this purpose, a number of independent experts were invited to prepare papers on the trends and prospects of research training in their respective countries. These were discussed at a seminar organised with the support of the Dutch Ministry of Education and Science, and held at the Royal Dutch Academy of Arts and Sciences, Amsterdam on 17-18 March 1993. Professor Stuart Blume, who had been the rapporteur of the de Wied Committee, prepared a synthesis report based on the country papers and discussion at the seminar.

The synthesis report and the country papers were discussed by the Group on the Science System, and then by the Committee for Scientific and Technological Policy, which recommended that they be derestricted. This report is published on the responsibility of the Secretary-General of the OECD.

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PROBLEMS AND PROSPECTS OF RESEARCH TRAINING IN THE 1990s

by

Stuart Blume

Wetensschapsdynamica, University of Amsterdam

Summary

Until recently, postgraduate training of researchers was rarely an explicit concern of policy-makers or university administrators. It tended to emerge as the unplanned result of initiatives taken in the areas of higher education and science policy. As a result of the increasing scale of higher education – which has forced rethinking of a number of established practices – as well as changes in labour markets for scientists and budgetary constraints, the situation is now changing. Current attempts to develop explicit policies for postgraduate research training encounter a number of dilemmas. These include the problem of relevance (notably the issue of making research training relevant to a wider variety of careers than it traditionally has been); the location of research (questioning the central role of universities in national research systems); the increasing extent of internationalisation; and concern with improving the quality of research training. In many Member countries, research training structures are being re-examined. The establishment of the Temporary International Consultative Committee on New Organisational Forms of Graduate Research Training (the de Wied Committee), which reported in 1991, is indicative of this new thinking.

A major issue of debate today concerns the "quality" of research training. While quality was traditionally taken to imply production of a thesis that represented a significant contribution to scholarship, many today emphasise instead the training process. In the latter view, quality implies competent training in research methods and processes. While there are major differences of opinion on this view, it is generally agreed that adequate preparation of the student prior to doctoral training and adequate supervision are both vital. How are these requirements to be guaranteed? Regarding the first, there is a growing, if not universally shared, sense that an initial year of formal preparatory training, possibly culminating in the awarding of a diploma, has much to commend it. Regarding the second, a number of suggestions have been made as to how good supervisory practice can be encouraged. They range from training in supervision to financial

sanctions for institutions or departments that appear to be deficient. Formal supervision is only part of what is involved, however. In a well-functioning laboratory, much informal supervision is available from postdoctoral fellows and advanced PhD trainees. Providing such an environment, not only in the laboratory disciplines but also in the more individualistic disciplines (the humanities, the social sciences), has been a major stimulus to the establishment of new structures. Thus it is that, in a number of Member countries, new structures are being set up, which are modelled indirectly on the North American idea of the graduate school.

As already indicated, one stimulus to current thinking is the notion that young researchers trained to the PhD level must move into a wider range of occupations than they have in the past. This view leads to the claim that more PhDs are "needed", at least in certain disciplines. In many Member countries, however, labour markets for PhDs have not evolved in line with this perception. Industrial employers in particular tend to view the PhD as too "academic": not really equipped for economic life. If economic demand is to be brought into line with prescriptive forecasting, changes will have to be made in certain aspects of the training process, as a number of countries have recognised. No less important, however, is the need for initiatives directed towards employers, which are designed to influence "prejudices" that may no longer correspond to reality.

The international dimension of research training is also becoming more conspicuous and more complex than it was in the past. This is partly the result of attempts to strengthen ties between scientific communities within the European Union. Political and economic motives, as well as concern with quality and efficiency in the use of scientific resources, play a role here. There is a growing commitment to enhancing the international element of postgraduate research training, through mobility schemes and (more controversial) harmonisation of admission criteria and standardisation of preparatory courses.

Concerns with making the PhD relevant to industrial and other social interests must not lead to a neglect of the needs of the higher education sector itself. If the quality of future training is not to suffer, it is important to ensure that educational institutions have access to a share of the more talented new PhDs. Expanding possibilities for postdoctoral employment – the number of "postdocs" – is therefore necessary. It is no accident that in the United States, where a significant labour market for PhDs has emerged, postdoctoral training has now become the endpoint of research training.

Background

In the 19th century German university, generally taken as the birthplace of academic research training, scientific work was regarded as part of normal university studies. At the beginning of the present century, academic examinations in Germany were intended precisely "to test the students' ability to do scientific work ... the principal part of the examination is therefore a scientific treatise, the dissertation ... [which] is printed as an initial specimen of scientific work, that is to say, is submitted to the judgement of the scientific world..." (Paulsen, 1906). As is well known, the training offered in Germany proved highly attractive to many of the best young scientists of other countries, and the

German model exerted a strong influence on educators in other countries. Following the report of an official committee, British universities began, from 1917, to offer research doctorates, partly in an attempt to attract American students away from German universities (Germany and Britain were then at war). The model was adopted and elaborated in the United States, initially at Johns Hopkins University (Kohler, 1990).

In the traditional European model, with a lengthy first degree involving an apprenticeship in research (generally viewed as the equivalent of the American master's), there was room for both personal development and specialised training. Further scientific work, leading to the title of "doctor", was not conceived as a training in research, but as research itself. Thus, going beyond the first degree entailed a commitment to a career in science. The titles awarded for demonstrable contributions to scientific knowledge ("doctor", and then, in Germany, the "habilitation") were, typically, stages in the scientific career. Work towards the doctorate was the first such stage, and those engaged in it were typically assistants to a professor. This is changing in many OECD countries, though important remnants of the old system still exist in many places. It is because of the informal character of doctoral work and its traditional association with the early stages of an academic career, that in some countries few if any data are available on doctoral students or trainees (see the Spanish case study, for example).

Changes began with the introduction, typically 20 to 30 years ago, of a shorter first degree. Most countries have tended to reduce or eliminate the research element. Research training would henceforth be reserved for the few. The second and more recent stage entailed rethinking the form, structure, and function of doctoral work. Clear indications of this change are provided by the history of the doctorate in France and in Italy. The "historic" doctorate in France was the *doctorat d'État*, introduced in the 19th century. In many disciplines, it took many years of sustained research to earn this highly prestigious title, which represented a major and original contribution to science or scholarship. In the 1960s, a distinctive "short cycle doctorate" (*doctorat de troisième cycle*) was introduced. It was to require some two years of doctoral research. Both doctorates were offered, along with two other types of doctorate less relevant to this study: the *doctorat d'université* and the *doctorat d'ingénieur*. In 1984, the system of multiple doctorates was abolished and replaced by a single doctorate, to be earned in from three to five years of doctoral study and research. Reform in Italy is still more recent. As the Italian case study explains, the introduction of a PhD-type doctorate dates from the reform act of 1980, and, although it is only a little over a decade old, it is already undergoing substantial modification.

Educational considerations have typically dominated discussion of the functions, as well as the funding, of universities. In most higher education systems, as one authority has recently written, "the first-degree level has historical primacy, predominates numerically, and possesses a deep hold on traditional thought and practice. It comes first in budget determination, public attention, and the concerns of government. Graduate or advanced education is then prone to develop at the margin, as an add-on of a few more years of unstructured work for a few students." (Clark, 1993, p. 356.)

As this view suggests, postgraduate training of researchers has rarely been an explicit concern of either policy-makers or university administrators in most OECD countries. Postgraduate research training typically fitted uneasily between the traditional

concerns and responsibilities of higher education policy (*e.g.* decisions about the universities and the conditions of study within their walls) and those of science policy (*e.g.* decisions about the allocation of research funds). Co-ordination was often lacking between these two areas of decision-making, so that postgraduate education "policy" was often no more than the unplanned consequence of interaction between these two sets of processes (Blume and Amsterdamska, 1987).

This situation is changing, and the past few years have witnessed growing attention to postgraduate training as an object of policy. There are a number of reasons for this. An important one is the continuing evolution of higher education systems in general. The shift from "elite" to "mass" higher education, which has been signalled in many OECD reports over the years (for example, Trow, 1974), has structural implications which cannot be understood purely in terms of numbers. It entails a rethinking of the role of higher educational institutions; of the boundaries between traditional universities and other postsecondary institutions (and in particular how research capacity is to be distributed or concentrated); of teaching methods (including research training as an instrument of general pedagogy and as a component of traditional "undergraduate" education in many European countries); and of institutional management. For political as well as financial reasons, government budgetary policies are increasingly rewarding "performance": efficiency in the use of resources. Changes in the labour markets for highly qualified personnel are a further factor, for there are clear divergences between areas of rapidly growing economic demand (such as information technology and the life sciences) and areas of minimal (or at best stable) demand.

As governments have gradually come to give specific attention to the quality, effectiveness and scale of research training, universities in many countries have been forced to scrutinise practices which may never have been made explicit. The increasing internationalisation of higher education also plays a role here, particularly within Europe. As students, graduates and young researchers become increasingly mobile (particularly as a consequence of EU schemes such as ERASMUS, TEMPUS, and the Human Capital and Mobility Scheme), international comparability of practices as well as harmonisation of requirements and standards become issues that require examination.

Current dilemmas

This report will have a good deal to say about new approaches to research training, partly embodied in new structures, that are emerging in many OECD countries. It is important first, however, to understand what lies behind the various initiatives, what they are responding to. In part, of course, policy-makers are concerned with the efficient use of resources, a concern in many policy areas today. Yet both national policy-makers and university scientists are also aware of more complex changes that bear on the training of future generations of researchers. The role of higher education institutions, their relations with the economy and society, their function with respect to national research policies, the international dimension -- all these themes are hotly discussed today. New initiatives are taken against the background of these discussions, which also create important dilemmas.

Relevance

The notion of "relevance" is an important theme in the current discussion of research training, and the one perhaps most emphasised by governments as well as by student demand. The Dutch government, for example, quite explicitly saw a relationship between the new structures for research training then being planned and the country's strategic science and technology policy interests.

> "As far as science policy is concerned, these areas extend over the entire spectrum of research in the exact sciences, arts and social sciences. Scholarly weight, social relevance, the need for graduates and, above all, the areas in which different countries specialise will be the determining strategic factors... The policy document 'An economy with open borders', issued by the Minister for Economic Affairs, stressed that a sound knowledge infrastructure is essential for the competitive position of the Netherlands and for creating a climate which will encourage companies to establish themselves in the country and thus foster high-level economic activity. Research schools, notably in the exact sciences and in engineering and technology, will form a significant element in [this] knowledge infrastructure..." (Ministry of Education and Science, 1989.)

The Australian case study very explicitly forecasts a shift in the intellectual basis of research training: "research training will therefore become increasingly related to solving the problems raised by broader social and economic issues rather than those raised by the traditional disciplines of science."

The concern with relevance on the part of national authorities seems to have two distinguishable dimensions. On the one hand, and most obviously following from statements such as those above, is a concern with the kinds of disciplines in which scientists are being trained. While few today are thinking in terms of formal manpower planning, there is in many countries an assumption that shortages of scientists are to be expected in specific scientific areas. Associated with this idea, though logically distinct from it, is the notion that the function of doctoral research training has – or must be – changed.

This second aspect of relevance is actually more fundamental, for it relates to the traditional connection in many countries (Japan being a partial exception) between doctoral training and preparation for an academic career. Central to many of the initiatives to be examined here is the objective of making doctoral training relevant to a wider range of occupational careers. This implies, for example, that the trainee researcher should become familiar with the ways in which research is typically pursued outside the university, *e.g.* by working in teams and with colleagues from other disciplines. These developments are far from straightforward: they pose difficulties and dilemmas. Some argue, for example, that the ideal environment in which to become a researcher today must offer breadth – a corrective to the intense specialisation of thesis research. Others, instead, emphasise the importance of specialisation, of socialisation into the relevant disciplinary/professional culture. Some argue that those preparing for an academic career should receive different research training from those preparing for a career outside the university, for instance in industrial research and development. Others find this inappropriate. Moreover, decoupling PhD training from preparation for an academic career must

in some way correspond to the emergence of a broader market for research skills. Here the various scientific disciplines present clear differences. In chemistry, a doctorate is indispensable for any professional career, but for the engineer it is optional. In some business-related fields, such as management, the PhD may now be acquiring market value. How does society come to attach a value to possession of the PhD degree that is commensurate with the investment which earning it entails?

Nevertheless, as many of the case studies show, there are major difficulties involved in making the PhD more relevant to non-academic employment. Attitudes on the part of employers are changing only gradually; in many countries industry tends not to perceive the PhD as very relevant for its needs, so that economic demand remains low. This is clearest in Japan, where industry appears to be very negatively disposed to doctoral training provided by the universities, preferring to recruit at the master's level and provide further training itself. The Japanese case is also exceptional in that in many disciplines the doctorate has typically not been a prerequisite even for university employment.

Location of research

Universities are traditionally pictured as the privileged home of basic research, unique in their coverage of disciplines, in the opportunities for interdisciplinary co-operation they create, as well as in their simultaneous commitment to both research and teaching. Unlike other institutions, universities should find their scientific work endlessly reinvigorated by a constant influx from the new generation. Today, this picture is no longer so convincing. Teaching and research are being forced apart (some of the reasons will be discussed below); many fields offer relatively few opportunities for the influx of new young enthusiasts (complaints of stagnation and lack of "new blood" are frequent); and it has become increasingly apparent that, in many European countries at least, structural rigidities are creating strong barriers to the emergence of interdisciplinary work. The result is that in a number of Member countries, with Germany figuring significantly among them, the role of the university in the national system of basic research is increasingly being questioned.

Research training is not, of course, limited to the universities. A good deal of training is provided informally, on the job, and in the growing numbers of industrial training centres. In addition, it is well known that in Central and Eastern Europe, the Soviet model – in which research was located principally in the Academy institutes and not in the university – was widely adopted. As the case study of the Czech Republic indicates, research training took place principally in the Academy institutes, where the most advanced research facilities were located. In a number of Western European countries also, much of the best scientific work takes places in institutes which are not formally part of the higher education system. France is the best-known example, and it is there that the phenomenon is most highly articulated. Many promising young scientists work on their doctorates within the laboratories of public organisations such as the CNRS and INSERM or in industrial laboratories, where they are supervised by a senior scientist approved by a university. Of course, university departments and CNRS laboratories, for

example, are typically highly-integrated: relations have nothing of the rigidities and the competitiveness characteristic of the old East European system. Nevertheless, in France, and to some extent in the peri-university institutes of many other OECD countries, universities have no monopoly on the training leading to the PhD degree. However, they may have a monopoly on formally awarding the title of "doctor", and in France they have a monopoly on the DEA (*diplôme d'études approfondies*), which is a prerequisite for admission to doctoral work. The situation is somewhat the same in Japan, where a special type of doctorate is available for those carrying out their dissertation research in government or, more importantly, industrial laboratories. Rethinking the structure and organisation of graduate research training necessarily involves rethinking the roles of these institutions – all the more as pressures on universities may increasingly be driving frontier research into other institutions.

Internationalisation

A 1987 OECD report on postgraduate education (Blume and Amsterdamska, 1987) pointed out that the question of international composition had arisen as a policy issue in few OECD countries: in the United States, where concern had been expressed at the high share of foreign students in some disciplines, most of whom would be leaving the country after their studies, and in France, which was deliberately seeking to increase the numbers of foreign students. In most OECD countries, especially those where education was given in a minority language or where educational structures were atypical, both numbers and concern were minimal. The report also noted that, from the point of view of science, spending a period of time abroad has often been very important to the careers of productive scientists. For many Europeans, this often entailed in the past a postdoctoral stint in a leading laboratory in the United States. Personal contacts between senior members of the scientific profession played an important part in arranging these matters. Numbers were relatively small.

Today, the situation is changing, as the international dimension looms much larger and has become more complex. In the last decade or two, and notably under the influence of a growing European consciousness, a new phenomenon has emerged. The vision of a European scientific and technological community, in particular, has meant that older patterns of exchange, often based on scientific contacts between individuals, have been supplemented by a variety of structural initiatives designed to encourage young scientists to go abroad. This should enhance the European dimension of scientific work. Thus, flows of young researchers are both growing and are increasingly being channelled in line with this political-scientific aspiration. Moves to harmonise requirements are, in part, a response to this evolution.

Quality

How to train young graduates for research efficiently, in terms both of use of resources and of length of training, to a high, and internationally-comparable, level is a fundamental question in the current debate. The context is which it is posed is also

important, for it constrains the potentially workable solutions. Certain dimensions of this context have been alluded to: the demand for relevance, the changing institutional location of research, and the international dimension. Another is the "massification" of higher education, which requires educating far greater numbers of students and makes it impossible to sustain traditional pedagogy, including preparation for research, as part of normal university studies and intensive contact between teacher and student. As Clark puts it, "Rather than involvement in research, the vast majority of students primarily need systematic, sequential course work." (Clark, 1993, p. 359.) Pressures on the teaching function of higher education institutions, often resulting from resource constraints, have meant that students have generally increased in number far more rapidly than staff. Many universities have sought to solve the problem by employing postgraduate students. As a result, in some countries, these students are beginning to complain that their teaching tasks actually take up far more time than their formal obligations allow for. This may be having negative consequences for their research. More fundamental still is the question of how traditional research activities and advanced research-related training are to be accommodated, and to some degree protected, against the new pressures. This is part of the reason for universities' and professors' concern to evolve appropriate structures for research training. After all, a group of researchers in training is vital to the research interests and reputation of university scientists in most disciplines.

While professors and other senior faculty, confronted with a growing administrative burden, can only with difficulty make time for their own research, research students generally have few non-research duties. Because they devote almost all of their time to research (as do postdoctoral fellows, but in Europe these are few in number), research trainees play a dominant role in the practical performance of university research. Studies carried out in universities in the United States make clear how crucial research students and postdoctoral fellows are seen to be for the effective functioning of leading science departments (Breneman, 1978). Any major cutback in numbers, or any dramatic shift in the conception of doctoral work (for example, a growing emphasis on the acquisition of research skills and a diminishing emphasis on the originality of the research carried out), could have enormous consequences both for universities' capacity to fulfil their research functions and for individual productivity.

New structures are emerging in part because of pressures being generated within the higher educational system, as suggested above. But what should these new structures encourage? How is research training of high quality to be provided? It is in this context that the relation between research student and supervisor – the nature and quality of supervision – has become a central issue in a number of countries. Traditionally, "sitting at the feet of a master" was the norm: an apprenticeship in which one learned how research was done by deep immersion in the work of the master. For many reasons, that process no longer suffices. The scale of scientific research and the numbers being trained in research are simply too great for such a system to work effectively. The negative consequences of the structural pressures emerging within the university may be going beyond the growing likelihood that students or trainees will be used as source of cheap instructional labour. Pressures on scientists to be productive may also raise problems, for there is as much risk that PhD students may be exploited for research purposes as well. It may well be, as an eminent Cambridge biochemist recently claimed in an interview, that

there are some supervisors who "consider it the student's job to get research done for the supervisor to publish, whereas others see their role as promoting and encouraging the student's scientific development".

Rethinking the structure of research training

The importance of a fundamental re-examination of the structures of postgraduate research training, and of its international dimension in particular, became recognised at the political level. In the summer of 1990, the Dutch Minister of Education and Science, in collaboration with his Belgian, French, and German colleagues, established an international advisory committee with the following terms of reference:

> "to consider and compare the new organisational forms of graduate research training on a doctoral level currently emerging in many European countries of which the Netherlands is one example;
>
> "to provide indications and recommendations that allow for more co-operation at the level of graduate training;
>
> "and to sketch ideas for the further evolution of these new systems of graduate training".

Professor David de Wied, ex-President of the Royal Netherlands Academy of Sciences, was appointed Chairman of the committee, which reported one year later. After clearly showing similar trends in the structure of research training in the four countries involved, the committee's report (1991) went on to elucidate some of the major problems. These included major differences in opinion regarding "quality" in doctoral training, which reflected, in part, differences in styles of working in different disciplines. Nevertheless, the Committee concluded that it was vital that research training be provided within environments adequate to the task and where good supervision could be guaranteed. The Committee argued for a more formalised and structured first year of doctoral training, with clear and specific functions:

> "first, it should provide a formal training in methods of research... and initial exposure to the practices of original research. Second, it should provide scope for evaluation of the suitability of the candidate for the rigours of a full PhD training. Third, for those who decide on a change of course, it should facilitate movement out of the university" (p. 42).

The committee found scope for gradual harmonisation of the content of this first year in specific disciplines in the countries represented. This would contribute to enhanced international mobility of young researchers, seen as a major priority, and would benefit both the individual and the sponsoring and host institutions. Nevertheless, mobility schemes must not become major bureaucracies: they should build on established contacts within the scientific community.

Subsequently, in line with the recommendations of the de Wied Committee, ministers of the countries concerned, as well as of Denmark, committed themselves to enhanced international collaboration and to a degree of harmonisation between their

systems. In October 1993 representatives of scientific organisations from these countries, along with delegates from other European countries, participated, in Amsterdam, in an international conference that addressed practical possibilities for further collaboration and internationalisation. The conference recommended a number of steps to be taken by international, national and academic bodies, including expansion of international mobility programmes, greatly increased numbers of postdoctoral positions, and the opening up of national fellowship and traineeship schemes to nationals of other countries, a practice that already exists in some Member countries.

Quality

Finding how to provide high quality training in research that is internationally competitive, given current financial constraints and political priorities, is the fundamental issue confronting policy-makers today in this regard. Yet the question of what precisely "good quality research training" is and how it should be assessed has become a vexed one.

To reiterate, preparation of a doctorate was, in the past, preparation for a life of academic scholarship. In Europe, those working on their theses were junior university teachers, acknowledged scholars, albeit at a local level. Receipt of the doctorate symbolised admission to the international community of science or scholarship. The thesis was expected to demonstrate appropriate maturity: the ability to formulate and carry out an original and significant piece of scientific research. In the European university, unlike its North American counterpart, little attention was devoted to how the appropriate skills were acquired. The assumption was that to be set to work in a productive environment, under the aegis of an eminent and inspiring professor, would be enough. All depended on the quality of the final product, which would be assessed by something akin to conventional peer review.

Today, some scientists continue to emphasise the product: they insist that the test is whether a dissertation represents a significant contribution to knowledge. However, the argument is now made that good quality research training means competent training in the processes and methods of research. Its basis is clear. Skills are embodied, appropriated, "marketable"; they are readily transferable in a way that research results (however original) are not. Emphasis on providing a set of research skills reflects the dominance of the market for scientists, that is, of labour market considerations. In the United Kingdom, the Committee of Vice-Chancellors and Principals has argued for a middle ground: the PhD should be "both a product, an original contribution to knowledge, and a process, the training of a researcher. The only way to accomplish such goals within a four-year time period is to define the thesis topic carefully and to accept the notion of a PhD programme with formal training elements" (UK case study). At present, both views are held, but the emphasis on skills and process is becoming particularly important precisely in those disciplines that enjoy a large extra-university labour market, the natural and technical sciences above all. In the liberal arts, in particular, emphasis continues to be placed principally on the traditional product. However, for one position as for the other, there is

a lack of operational criteria for assessing the quality of a particular programme of training. This is a matter to which further thought must certainly be given.

There is nevertheless widespread agreement that it is vital to prepare the student for doctoral research. A first year spent principally on course work and on acquiring the skills needed for research is increasingly seen as necessary. This was the view of the De Wied Committee, which was impressed by the French DEA. For the university, the right to award the intermediate qualification of DEA is a necessary prerequisite for the right to offer the doctorate in a particular specialty. Similarly, for the individual, access to doctoral training is available only to those who have first obtained the DEA. The strength of the DEA, the de Wied Committee felt, lay in this double element of selection. First, at the institutional level, postgraduate training could be limited to those institutions (or groups of institutions) which a specialist evaluation committee judges adequately equipped to provide it in terms of staff qualifications, resources, and educational plans. Second, it provides a means for selecting those few students possessed of sufficient ability and motivation. This weeding-out process nevertheless provides students who change their minds or are felt to be unsuitable with skills which can be of use elsewhere.

The structure introduced a decade ago in Italy, like the one being introduced in the Czech Republic today, has certain features in common with this model. The central government has reserved the right to approve proposals for doctoral programmes leading to the new *dottorato di ricerca*. In both these countries, as in France, it is the task of special commissions to approve the proposals for doctoral programmes made by universities. In Italy, a doctoral programme must provide a mixture of course work and individual research and must involve a minimum of three and a maximum of ten postgraduate students (see the Italian case study, which also provides information on the difficulties encountered in introducing this new structure into Italian universities).

There is no doubt that, in many cases, the requirement to provide specialised courses for doctoral students can create difficulties for small departments and small universities. There may simply be too few doctoral students, or too little expertise among the staff, to make a sufficient range of coursework possible. This can be an important incentive for collaboration between institutions and the development of network or consortium structures. However, such structures seem more compatible with national traditions and institutional cultures in some countries than in others. As discussed below, very large numbers of such networks have been created in the Netherlands and in Denmark. By contrast, in the United Kingdom, where they have not been deliberately encouraged by government policy, such initiatives are rare. The Institute of Historical Research, formally part of London University, provides graduate courses which are open to students of other associated institutions, but it is a rare phenomenon in the United Kingdom (Becher, 1993, p. 120).

A second, and much discussed, aspect of quality concerns supervision. Many European countries furnish evidence of widespread failure to provide research trainees with adequate guidance and supervision. Large numbers of research trainees receive too little formal supervision. Many see their supervisors only once in two or three months. A British survey carried out ten years' ago found that while students in 91 per cent of physical science departments met their supervisor at least once a week, this was true for

only 35 per cent of social science departments (UK case study). Lack of supervision is reflected in widespread dissatisfaction with the quality of supervision, but also with other aspects of the training experience. Isolation is a commonly reported complaint. Where lack of formal supervision is compensated by integration into an effective research environment this may not be a serious problem, for the trainee can profit from daily contact with other more experienced scientists. In the social sciences and humanities, daily contact of this kind is not the rule, the norm being that research students work at home or in libraries or archives. Countries, such as the Nordic countries, where research trainees are typically given university appointments and have office space, are an exception. A recent German study found that "most of the history professors who were interviewed did not know precisely how many doctoral students they had (Gellert, 1993, p. 66)". The problem is partly one of transition and is more acute in countries (and disciplines) where the training aspect of doctoral research has made little headway. To accept supervision as a formal responsibility, let alone as "teaching", may demand a profound change of perspective. The British Economic and Social Research Council (ESRC) training guidelines merit recalling on this point:

> "Supervisors should provide full opportunity to discuss with students alternative management strategies for their research. They should ensure an effective mix in the student's work of reading, information search and retrieval, data processing, and writing, allowing theory and practice constantly to confront each other, both to sharpen the analytical skills and to improve the effective communication skills of the student. Sharing with the research student the process of the supervisor's own research is particularly useful."

Poor supervision, inadequate knowledge of research techniques, and inadequate motivation on the part of the student have regularly been identified as major influences on the quality of training and on the rate of successful completion of doctoral studies.

How is good supervisory practice to be encouraged? The question is a new one in most higher educational institutions in the OECD area. The implicit assumption is that a structure of the graduate school type will generate "moral pressure" on academic faculty who work and teach within it. This is not certain, of course, and experience is largely limited to Canada and the United States. Other provisions are certainly necessary. Information on supervisory practice should be available in the form of guidelines or even courses.[1] Annual monitoring of the trainee's progress can be required. To be effective, however, such a system requires that reports be reviewed within the university at a level at which action can be taken. To whom is a supervisor responsible? Who can call him or her to task for providing inadequate supervision? Issues arise which can easily appear to conflict with traditional notions of academic freedom. Can the university penalise departments or individuals who appear to be failing in their duties as supervisors?

Such procedures fit relatively easily into North American universities but are less compatible with many university structures in which professors, individually or collectively, may continue to insist on traditional prerogatives. In many universities, the possibility of bringing either moral or financial pressure to bear on a senior professor simply does not exist.

Where this is so, and where there is a clear perception of failure, pressure from outside the institution may be the only possibility. How is this to be accomplished? One possibility, in line with current thinking, is to regard the research trainee (or student) as a consumer whose rights require some sort of protection. From this idea evolves the notion of a formal contract between a trainee and the scientist providing him with "training services". The idea will seem very radical to most university people. Given the dependency of most universities in most OECD countries on state finance, the notion of sanctions imposed by funding bodies is more familiar, if hardly welcome.

The forces which stand in the way of improved research training must not be underestimated. They are not limited to traditional notions of autonomy and professorial dignity. There is an important paradox here. Precisely the pressures on the university to use shrinking resources wisely and to "produce competitively" may generate not only new postgraduate training policies, but also barriers to their implementation. In a recent British study, students complained of lack of assessment of their progress, of lack of clarity as to what exactly was expected of them, of being "exploited" by their research group, treated as "dogsbodies", and given routine and unrewarding chores" (Becher, 1993, p. 139). What lies behind these complaints?

One source of pressure, which perhaps affects the best research groups most acutely, derives from the competitive research funding system. Attaching research training to organised and substantial research programmes has clear advantages, but when financing considerations are involved, there are, inevitably, tensions between the requirements of pedagogy and those of competitive research. "The funding is a tricky balancing act when you're training graduate students. You have to give them leeway to make mistakes, yet unless you make progress in the laboratory, there's no funding" (Gumport, 1993, p. 266).

A second source of pressure derives from the educational system: departments feel the pressure to cope with (possibly) growing numbers of undergraduate students with stable or shrinking resources. The temptation to use financially hard-pressed research students as a source of cheap labour is very real. For their part, as many stipends are barely enough to live on, students typically want money as well as integration with their seniors; fulfilling a recognised function within the department provides some of this integration. Especially in the arts and humanities, perhaps, it can reduce students' sense of isolation.

The strength of these integrative forces is made clear by the Italian case study. When the new doctorate was introduced in Italy, together with an associated fellowship scheme, fellowship holders were forbidden to teach or engage in any other kind of university employment. They had to restrict their attention to their doctoral work. "But", the Italian case study continues:

> "it has proved difficult, if not impossible, and certainly not desirable, to exclude doctoral students from many activities that mark university life..."
>
> "The push by doctoral students and the pull of faculty have led to [a proposed new regulation which] would make it possible to employ doctoral students in support activities for lecturing and research, outside as well as inside the university, and as tutors of undergraduate students. In terms of employment regulations, doctoral

students have the same rights concerning conscription and maternity leave as any other worker."

It is important to appreciate that ensuring the quality of training in research entails much more than the quality, let alone the amount, of supervision. In one British study, in which large numbers of students were interviewed, it appeared that "the commonest concern was with a lack of structure rather than a lack of attention". Quality and extent of formal supervision, though an important issue in improving doctoral training, is far from the only point, as these students clearly recognised. Perhaps most fundamentally, the issue is one of the proper mode of integrating these scientists in training into a productive and stimulating environment.

What is a "productive and stimulating environment" from a research training point of view, and how is it to be provided? This is a different question from the more familiar question of the organisation of (university) research and the role of departments and other kinds of centres. The characteristics necessary for a research training environment can, in principle, be built into research structures centred on disciplines or themes. The issue here is to combat intellectual and social isolation and to provide technical and personal resources and support. An environment suitable for providing high-quality research training must have a number of characteristics: it must give the trainee the opportunity to interact regularly with his/her peers; it must provide opportunities for interacting with senior scholars, both in regular colloquia and informally; it must include postdocs (or other experienced and more or less full-time researchers); it must be properly endowed with instruments and other necessary facilities; it must almost certainly participate in a wide network of international contacts; its research must have some degree of coherence and integration; it must be large enough to make all of this possible. This combination of characteristics will generally be found in a good laboratory in the natural sciences, although it does not reflect common ways of working in the social sciences and humanities, where research has traditionally been more individualistic, with researchers not necessarily tied to physical facilities. Of course, this traditional picture is no longer wholly accurate, and today there are many large-scale projects in areas such as economics, sociology, political science, linguistics.

Considerations such as these have inspired a number of the developments discussed in the following section.

New structures

The report of the de Wied Committee characterised the new structures emerging in the four participating countries as having been inspired, in one way or another, by the North American graduate school. The same is certainly true of new developments in a number of other OECD countries. The present report sets out some of the salient features of this model, drawing on the US case study, before discussing how it has been adapted to distinctive national university structures and traditions.

In American and Canadian universities that provide training leading to the PhD degree, responsibility for this training is almost always vested in a distinctive administra-

tive unit, the Graduate School (sometimes, the Graduate School of Arts and Sciences). Its head is a senior officer of the university, usually called the Dean of Graduate Studies or Dean of the Graduate School. This unit is responsible for admitting students to postgraduate study in all disciplines. "The graduate school is entrusted with defining and maintaining standards in all units. It does this by setting standards for admission which departments may exceed, but not drop below, and by establishing general requirements for all graduate degrees." Formally, the Dean of the Graduate School is responsible not only to the head of the university, but also to a graduate council (with faculty and, often, student members). This council reviews requests for new postgraduate programmes. A major goal of this structure is "to ensure equity among all programmes and by codifying requirements for all degrees to ensure that students are aware of the requirements and are treated fairly". The graduate school does not itself employ faculty: faculty members are employed by the schools or departments in which they teach and carry out research. The graduate dean's authority is essentially symbolic, that of an "advocate for scholarship, for research, and for graduate students and faculty in all departments..." Graduate deans can function as 'trusted brokers', whose interest is "promoting scholarship and good graduate education". Graduate schools may have funds at their disposal which can be made available to departments for exploratory research or for providing fellowships for postgraduate students.

The attractiveness of the North American model has derived from the fact that it has seemed able to ensure effective and efficient training of researchers on a much greater scale than has been usual in European universities. In recent decades, as this and earlier OECD reports document, not only has research training in Europe grown dramatically in scale, but there has also been an increasing desire to ensure both effective preparation for research (advanced course work) and demonstrable inculcation of the necessary formal skills. The graduate school has appeared designed to provide precisely for all of this.

In the United Kingdom, as discussed earlier, universities have been put under particular pressure to ensure the efficiency of the postgraduate research training they provide. Repeated criticism of the time taken to complete the PhD, particularly in the social sciences and humanities, and the financial sanctions introduced as a means of forcing universities to reconsider their practices, have had a number of consequences. Among these are the growing emphasis placed on formal instruction in the early stages of research training (ESRC now requires it to constitute up to 60 per cent of the first year). As the UK case study documents, a number of structural changes, directly inspired by the US model, are now being made in various British universities. A small number of British universities (including the University of Warwick and University College London) have established institution-wide graduate schools with responsibilities and authority similar to those of their American counterparts. In one case (Manchester), a disciplinary/faculty approach to the organisation of research training (more akin to the Dutch, French and German models discussed below) has been preferred. However, as the authors of the British case study make clear, "most institutions have not yet adopted new structures for the management of postgraduate research training. Indeed, it remains an open question whether these initiatives can be adopted and adapted across the higher education system as a whole."

Japan provides an interesting contrast. On the one hand, Japanese universities do have graduate schools roughly modelled on their American counterparts, although, according to the Japanese case study, administrative forms in different universities range from faculty-based graduate schools to centralised university ones. On the other hand, it seems probable that they function rather differently from American graduate schools: first, because of the small scale of doctoral training in Japan (discussed at length in the Japanese case study); and second, the authority of those who hold chairs in the Japanese universities. In Japan, as in many OECD countries, rethinking of postgraduate training has been inspired in part by changing views of the social function of the qualified researcher. As the Japanese case study puts it: "in 1990, the aim of doctoral degree courses came to include the training of people with high-level abilities and profound knowledge who are capable of working in various sectors of society, as well as the training of researchers to be employed at universities."

Recently, concerned by the small scale of PhD training, both the Science Council of Japan and the University Council have argued for the expansion and the strengthening of the graduate schools.

Many European countries have had similar concerns. The North American graduate school has been an important but indirect source of inspiration. The models being developed, though informally often referred to as graduate schools, are very different indeed. One important reason probably has to do with the distribution of power. Torn as it is between powerful national or regional government agencies (Ministries of Education) on the one hand, and traditionally powerful faculties on the other, the central university level lacks the power and authority to create an institution-wide structure for postgraduate training under its responsibility. The tendency instead has been to seek partial approaches, in which the distinctive disciplines play a central role.

The Netherlands' experience is exemplary in this respect. The shift from a traditional European pattern, in which research training took place informally, either in the course of university employment or via a research assistantship, has had three stages (see de Wied Report, 1991).

In the first stage, a 1981 Act of Parliament established both the conception of "graduate education" and the formal employment category of "research trainee". As a result, university education was to consist of a first phase of four years (unlimited study would no longer be possible), which – for a certain proportion of graduates – could be followed by a second phase. When the students selected finished the first phase, they would have the option either of following more specialised courses in the second phase or of following research training. The majority of those preparing their doctorates in Dutch universities are now typically "assistants in training" (AIOs). AIOs are employees of an individual university, usually with a four-year appointment. Generally speaking, AIOs are appointed on the basis of an open competition, in which specific vacancies are advertised in the university and national press. The second principal category of research trainees are supported from Research Council funds. These so-called "OIOs" are appointed on the basis of research project proposals submitted by their intended research supervisors. They are employees not of the university in which they work but of the Research Council.

In the second stage, starting in 1984, inter-university AIO networks were developed. The argument was that, in certain disciplines, research training of an internationally competitive standard could best (or perhaps only) be developed on the basis of collaboration between various groups. The government therefore proposed that the universities should gradually build up inter-university research training networks and made funds available for this purpose. Priority was initially given to disciplines in which traditional organisational structures were thought inadequate, in particular, the arts and the social sciences. By the beginning of the 1990s there were 114 networks in operation or in the preparatory stages in the Netherlands, 37 of which had received start-up grants from the government.

In the third stage, which began in 1990, the concept of *Onderzoekschool* (research school) was emphasised. On the basis of the advice of a Committee on Research Schools, the Dutch government decided in 1991 to institute a system of research schools, seen as research institutes of international standing which will provide structured postgraduate courses for researchers. A research school must be "a centre for high-quality research, forming an independent organisational unit with responsibility for the expenditure of the funds allocated to it by the executive board or boards of the parent institution or institutions. It is to have a sufficient number of young trainee researchers (as a rule about 40 or 50 in all) and, in addition, a number of postdoctoral researchers." It was envisaged that a national system of research schools should come into being in the course of the next five years or so. Initiatives should emerge from the individual universities (possibly two or more in collaboration) and need to secure the support of the university administration.

Having decided that some form of external accreditation was required, the government invited the Royal Netherlands Academy of Arts and Sciences (the KNAW) to take this responsibility. Approval of a proposal should take account of a number of indicators of quality, guaranteed continuity of support, international contacts, etc. Accreditation should be for a period of five years, although the precise advantages conferred by accreditation were far from clear. No extra funds were promised for accredited schools, although a special fund administered by the Research Council (NWO) would be available for promising groups preparing to apply for accreditation. In addition, the Ministry of Economic Affairs has established a special fund of Gld 44 million. This fund is available for technology-oriented research schools, which are considered of economic interest. An important criterion is close co-operation between industry and university, which should be manifested in a co-ordinated research programme. The KNAW established an accreditation committee, and at this point 19 schools have received official recognition, of which 14 (74 per cent) are in the natural and physical sciences. It is worth pointing out that, in contrast to their French and German equivalents (see below), the majority (58 per cent) of Dutch *Onderzoeksscholen* involve collaboration between universities (Faasse, 1993).

Despite major differences in their structures of study, developments in both France and Germany show some similarities with the Dutch situation. In both countries new discipline-based institutional structures have been created, *écoles doctorales* and *Graduiertenkollegs*.

In 1986, the West German *Wissenschaftsrat* (Science Council) proposed the creation of *Graduiertenkollegs* (GK):

> "The essence of the recommendations made to the universities is to behave like *Fachhochschulen*, to provide the opportunity for a majority of students to earn a degree in a shorter time and to put into effect the research university principle of unity of research by teaching by establishing separate sections of postgraduate studies."

By 1988, some 15 experimental *Graduiertenkollegs* had already been established, funded by the Thyssen and Volkswagen Foundations. The new *Program zur Forderung von Graduiertenkollegs*, which started in 1990, was intended to comprise some 200 such "schools" over the period 1990-93. The task of selection and accreditation in Germany is handled by the German Research Association (DFG).

Proposals for the establishment of GKs are formulated by the scientists involved and then presented, via the Länder, to the DFG. The Länder check, in particular, whether the proposed GK fits into their own planning of the development of the universities concerned.

As of May 1991, 202 applications to establish GKs had been made, of which 103 (51 per cent) had been approved. As of July 1993 the number of approved GKs had risen to 190. It has never been the Science Council's view that the GK system should encompass all graduate research training; they currently recommend a maximum of 600. Of the existing GKs, a negligible proportion involve collaboration between universities. Coverage of disciplines also seems very different from what it is in the Netherlands, with a large proportion (32 per cent) in the social sciences and humanities.

At *Graduiertenkollegs*, doctoral students should prepare for their dissertations by participating in interdisciplinary study programmes and by taking part in several research groups with related research themes. The primary aim is to counter excessive specialisation, especially in the humanities and social sciences. Innovative research programmes are deliberately encouraged, as is joint programming of research proposals. Students should be closely supervised. GKs tend to be organised around a theme and should be based on outstanding research groups: not every department in every university should have a *Graduiertenkolleg*. GKs are established within universities, though they may involve co-operation with a Max Planck Institute, for example. The number of teachers varies from five to 15. In addition, the GKs receive up to DM 60 000 for inviting guest teachers from abroad. They also have the possibility of appointing up to two postdocs.

In contrast to the Netherlands, where the government recommended a minimum number of trainees, Germany set the maximum number of students at each school at 30. Many of these are appointed to fellowship positions (*Doctorandenstipendia*) financed by the DFG, which pay a modest DM 1 400-1 600 per month. These fellowships are provided for a period of two years, with the formal possibility of a one-year extension. Admission criteria for students who wish to enter a GK include above-average qualification, scientific value of the planned postgraduate work, and willingness to engage in active co-operative work within the *Kolleg*. Moreover, beginning PhD students should not be over 28 years old. It seems likely that many of those given fellowships within GKs have already been working on their dissertations for some time. Other PhD candidates

admitted to the GK may be given other forms of (better paid) institutional employment, possibly with substantially greater teaching responsibilities.

Advanced courses are provided, and may be obligatory, though the extent and structuring of these varies from one GK to another. The DFG requires that, each year, all students present their work at a week-long colloquium, at which supervisors are also obliged to be present. Representatives of the DFG may also participate.

In France, as in the Netherlands, the recent development of *écoles doctorales* has built on existing structures established for graduate training (*troisième cycle*). The base has been the highly successful system of the *diplome d'études approfondies* (DEA) introduced in 1955 as a selective introduction to research training. DEA programmes require that the university or universities concerned present a formal application, which is evaluated by a national committee for the discipline. Upper and lower limits to numbers of students are set by national regulation. Despite the success of the DEA as preparation for doctoral training, it was felt that there were problems with the organisation of subsequent training. Some of these problems are specific to certain disciplines. For example, in fields like computing and management, it was felt that too few of the best students stayed on to work for their doctorates. By contrast, in law and medicine the volume and quality of university research was felt to be problematic. The completion rate, especially in the social sciences and humanities, was also felt to be too low. Proposals to establish doctoral schools were motivated by a number of related concerns. One, reflecting in part pressure from industry, was a commitment on the part of government to double the number of doctorate holders within five years, which resulted in a rapid rise in the number of scholarships made available. Another concern was the quality of training, including lack of supervision and formal instruction and the lack of formal seminars in which research students could participate.

In September 1990, when it invited universities to submit DEA proposals for the years after 1991, the Ministry of Education referred to the development of *écoles doctorales*, which would provide more structured research training. Universities were invited to consider grouping research and teaching units working in an established discipline or on a common theme. The "doctoral school" was to have a different structure than a DEA, for while a DEA could, in principle, involve collaboration among various institutions, a doctoral school was to be based in a given institution. Collaboration would in any event be limited to physically proximate institutions. Universities were told that DEA proposals formulated "in the spirit of the doctoral school concept" would receive financial advantage.

The main goal of the new schools would be to co-ordinate the efforts of research teams working in the same discipline, to improve the quality of supervision, to raise competition within and between universities, and to compensate for the excessive specialisation of a typical PhD. French policy emphasises this last point more than other national policies do. There is a view that new structures should be multi-disciplinary; in a sense, this better corresponds to a non-academic research environment, which typically involves different specialists working together on a common theme. Thus, a student working in a unit associated with one DEA would have access to courses in the same university in another DEA, through the medium of the doctoral school.

A more recent report recommended a rather liberal definition of the *école doctorale*. A special accreditation committee should decide upon each application to establish a doctoral school. The minimum number of students was estimated at 40, with at least ten senior researchers to guide them. It should remain possible to train doctoral students outside an *école doctorale*.

Discussion on how the new schools were to be structured proceeded for some time. Two possibilities were envisaged. One was to group DEAs in a single institution into a small number of doctoral schools. A second was to stimulate integration of DEAs in the same field in institutions located reasonably near each other. The first possibility seems to have become the more common, for relatively few French doctoral schools are inter-university.

In the first round of approvals, 32 *écoles doctorales* were founded in the *Île de France* region (30 of them in the humanities and the social sciences). They received special funds, amounting to a total of FF 4 million. By 1993, 45 schools had been established, with the emphasis still on the social sciences and humanities. In a distribution roughly parallel to DEAs, a little more than half were working in the social sciences and humanities (Faasse, 1993).

The Italian case study notes that current developments, including the development of inter-university consortia, could lead to network structures like those in the Netherlands. It is clear from the report, however, that effective means of co-operation have to be worked out in practice. In a number of other Member countries, where research training has not been so explicitly the object of new policies, new arrangements are nevertheless coming into existence as a consequence of developments in research policies. In both Belgium (Inter-University Poles of Attraction) and Canada, networks of research centres have been established as a means of strengthening research through collaboration. The Canadian government launched its programme in 1988, and, on the basis of 158 proposals, 15 networks were established. These networks, which group the country's best centres working in a specific field, have, as a subsidiary objective, enhanced research training. The same is true of the Belgian programme.

Developments in Australia have been rather different and are also worthy of note. The principal development, emphasised in the Australian case study, is the shift of university research from traditional teaching departments to university research centres. The establishment of these centres has been stimulated by a number of national government programmes that aim to enhance research quality through selectivity and concentration of resources and to involve industry on a structural basis in university research, through the co-operative research centres programme. As of 1992, the 800 centres were believed to account for 50 per cent of all university research. The Australian case study describes them as follows:

> "They are predominantly strategically directed and are increasingly providing a research training ground for research students at both master's and doctoral levels of study. The only study carried out to date on Australian research centres suggests that this sort of academic structure is emerging as a major challenge to the existing departmental structures... It is likely that they will play an increasing role as a training ground for postgraduate research students... Recent literature on research

training in Australia places emphasis on the need to create 'appropriate educational learning environments', to create 'collaborative groupings with academic staff and students', and to share facilities in group settings."

Developments in research policy are thus having a major effect on the structure of research training in Australia. In addition, however, the idea of the graduate school (as in the United States) is also beginning to receive attention. The Australian National University (ANU) has recently established the country's first US-style graduate school. However, the principal trend signalled in the Australian case study is clearly different from experience in France, Germany, and the Netherlands which have built on – rather than challenged – the traditional hegemony of the existing disciplines.

Labour market considerations

It is not easy to summarise experience with and views on the relations between research training and employment. This is because current discussions are a complex and not always clear mixture of positive elements (*e.g.* the magnitude and structure of existing labour markets for holders of doctorates) and normative elements (what the demand for PhDs would be if things were as they should be). As the history of scientific manpower discussions indicates, it is not always clear if forecasted shortages reflect the plans of employers or the intentions of science policy-makers determined to stimulate technological innovation.

Referring to circumstances in the four participating countries, the de Wied Report argued that "postgraduate research training is being gradually decoupled from its traditional association with the academic career. Much current policy is based on the idea that research training should more adequately cater to the needs of a wider range of social institutions, in particular industry" (p. 30). This perception underpinned a number of the Committee's recommendations. In the broader OECD context, however, the shift in the function of research training, and of the PhD degree, is by no means universal. In a number of countries, including some of those examined in depth for the purposes of this study, research training leading to the PhD degree remains associated – in the minds of both candidates and employers – with academic life and an academic career.

The first question to be posed concerns the existence, or the lack of it, of a labour market for PhDs outside the higher education system. Of the countries for which case studies were prepared, only the United States shows a clear relationship between research training and non-academic employment; whereas 31 per cent of 1971 PhD recipients obtained employment outside the higher education sector, this figure increased to 47 per cent of 1991 PhDs (US case study). This overall figure obviously conceals considerable variations among disciplines. Whereas 74 per cent of 1991 engineering PhDs left the university, only 16 per cent of arts and humanities PhDs did so. The US pattern is further complicated by postdoctoral fellowship positions, which are not categorised as "employment" but as "further study". In the physical and life sciences, more than half of the 1991 PhD earners took up postdoctoral fellowships, "a natural step in the path toward an academic research career... Postdoctoral study is rare in non-science fields." In any

event, it can be clearly seen from US statistics that the economic sector absorbed a considerable share of PhDs in engineering and the physical sciences.

This situation remains unusual, although comprehensive data on the employment of holders of PhDs are rarely available. For Italy, data are available thanks to a survey carried out by the *Centro nazionale delle ricerche* (CNR, National Research Centre), which shows that, of fully employed PhDs, 57 per cent work in the universities, with a further 17 per cent teaching in schools (Italian case study). For women, the share in universities is lower, and in teaching higher, than it is for men. Only 4 per cent are employed in the business enterprise sector. "The main reason put forward by the industrial sector," states the Italian case study, "is the mismatch between competence (holders of doctorates are highly specialised but rather old and too 'academic') and the needs of industrial research for people who are flexible and production-oriented and, where necessary, young enough to be retrained and reoriented to meet industrial requirements". This seems to be very much the pattern in European OECD countries.

Finnish industry, also, has not traditionally viewed researcher training as relevant or of much significance. According to the Finnish case study, only 7 per cent of PhDs worked in industry in 1985; 8.3 per cent of 1988 doctorate recipients entered the private sector, and 51 per cent remained in the higher education sector. The UK case study also suggests that labour market demands for PhDs in both the physical/natural and the social sciences are small and fragmented. Non-university employers are anxious to recruit PhDs only in very specific and defined specialties. Generally speaking, concludes the UK case study, possession of a PhD "would not seem to enhance the earning potential of employees in a labour market that has very few specific requirements for skills and knowledge acquired during three or four years of study".

There is little information on the implications of the economic climate for the labour market for PhDs. The Finnish case study suggests, although it lacks substantiating data, that the effects could be very significant. Reluctance on the part of employers to hire PhDs except in very specific areas is of course exacerbated by the current economic climate. In Canada, the recent recession has adversely affected the labour market for PhDs. Industrial employers are encouraged to hire recent doctoral graduates through an Industrial Research Fellows programme which subsidises salary costs and which is particularly attractive for small and medium-sized companies.

The attitude of employers is an important factor behind the lack of effective demand for holders of the PhD outside the higher education and research system. The PhD is frequently seen as highly academic, not "relevant" to industrial requirements. In Australia, for example, "the PhD is generally viewed by employers as a 'science' degree". Employers often prefer to recruit at the master's degree level where it exists. This tendency is particularly marked in Japan. In France, too, industry recruits significant numbers of DEA recipients in relevant disciplines, and this of course is partly responsible for the relatively low rate of passage from DEA to doctoral work. It may well be that initiatives designed to influence employers' perceptions of the utility of doctoral training are needed; for example, employing organisations could become more involved in the conducting of doctoral research. In addition, preparing the new PhD for non-academic employment may also require attention. It is important to recognise that employers place

high value on certain social skills: ability to communicate effectively with non-specialists, willingness and ability to collaborate with those trained in other fields, motivation, and so on. Improving the "match" between doctoral training and the labour market implies a series of subtle initiatives addressed both to higher education and the market itself.

In many countries, current policies are marked by a determination to ensure that a considerable share of PhDs should move into the economy. The problem, according to this analysis, is inherent in the nature of the PhD training currently offered. Broadly speaking, initiatives have been aimed at the content and structure of the training offered by universities: that is, they have accepted industrial views on the relevance of the PhD. Few, if any, initiatives have taken social attitudes towards holders of PhD as (part of) the problem.

Various analyses and initiatives are reported in the case studies. In some countries (*e.g.* Finland) concern focuses on the age at which the PhD is typically obtained, one at which people are thought not to be flexible enough to adapt to the demands of the non-university world. Strategies being developed to make PhD training more relevant to the needs of the economy stress topics of research, inculcation of discrete research skills (more transferable than substantive knowledge of a specific topic) and socialisation processes. The Finnish case study draws attention to a number of recent initiatives which seem to have been bringing about (as well as signalling) change. These include a scheme of the Finnish Academy rather like the CASE (Co-operative Awards in Science and Engineering) scheme described below, as well as a number of schemes initiated by large companies (such as Kemira in the chemical sector and Nokia in telecommunications/electronics) and by the Finnish Employers Federation.

As the UK case study points out, the Science and Engineering Research Council (SERC, a major source of support for doctoral training) has developed a number of schemes with this objective. Certain of these schemes have involved associating a specific firm with a specific doctoral project, as in the CASE scheme. There has been criticism, in particular, of PhD training in engineering, where "it has been argued that holders of the engineering PhD are not well prepared to enter the engineering environment of industry, with its practical and managerial requirements".

With this concern in mind, and following a recent report on the engineering PhD, a new kind of doctorate has recently been launched on a trial basis in three centres. Engineers are to be trained "in teams linked with industrial companies over a registration period of four and a half years. Instead of the traditional PhD thesis, the students are required to submit project reports and develop competencies necessary to the engineering industry."

The Italian case study refers to the notion of the "double curriculum" proposed by industrialists, one for an academic doctorate, the other for application in the business world. However, the Italian case notes that attempts to orient university and industry to one another have been "rather sporadic".

There is a potential risk that, with so much attention being given to rendering research training more relevant to economic (and specifically industrial) needs, the requirements of university research and teaching might be forgotten. What of the talented

young researchers whom the universities need to retain as the basis of their future teaching and research? In the United States, these people typically move on to postdoctoral positions. In the natural sciences, at least, these positions, not the PhD, are regarded as the endpoint of the research "apprenticeship". Since these positions are typically associated with externally-funded research projects, their numbers and distribution reflect the funding capacities of principal investigators (*i.e.* senior faculty) in the disciplines concerned. Although the presence of such a large number of so-called "non-faculty" on American university campuses presents acknowledged difficulties, the importance of the postdoctoral position in reproducing academic faculty is unquestioned.

Despite the longstanding existence of international fellowship schemes (such as NATO's), the fact is that in numerous Member countries the postdoc is only now being "discovered" by policy-makers. This is partly a consequence of the new and tighter structure of doctoral training (van Steijn *et al.*, 1993). A number of schemes are now being developed, principally in order to retain a share of the most talented young PhD holders for the university system. Most of these new schemes differ from the traditional pattern in the United States, where provision of postdoctoral training has tended to depend on research funding. This is undoubtedly a small element in the overall labour market for PhDs, but it may well be a critical one. The authors of the Australian case study recognise this and give the matter some attention.

A number of Australian reports have attributed a severe downturn in motivation among many of Australia's best young researchers, especially scientists to the lack of postdoctorate career possibilities. Since shortages in the university system are anticipated later in the 1990s, efforts are being made to expand postdoctoral fellowships. A three-tier fellowship scheme has recently been established by the Australian Research Council; between 1989 and 1991, 256 fellowships were awarded, over 40 per cent in the biological sciences.

The Human Capital and Mobility (HCM) programme of the European Union is an important new source of postdoctoral positions. Its objectives are, however, somewhat different from those outlined above, and they direct attention to the final principal theme of this analysis.

Internationalisation

Evolving out of a series of European Community initiatives that began in the 1970s, all of which have sought to promote mobility, the Human Capital and Mobility programme is receiving much attention within the scientific community today. Its primary aim is assisting the creation of a genuinely European scientific and technological community. Focusing on the scale and "Europeanisation" of the Union's research labour force, the programme makes fellowships available for postdoctoral (or to some degree in practice pre-doctoral) research in a country other than the candidate's own. The programme is substantial; it awards some 1 000 fellowships annually at present. The HCM fellowships are awarded through two competitive procedures: one in which laboratories apply for positions, and another in which individuals apply for positions. For both, the

programme covers all disciplines but emphasises the natural, technical and life sciences. The rapidity with which the scientific community has welcomed it bears witness to a important change in the research system. Internationalisation has acquired new significance for research training.

This is not to say that international aspects have not been important for many years. Some countries have had international fellowship programmes for some time (for example, the Canadian International Fellows programme, which brings 80 recent PhDs to Canada annually). Historically, one can distinguish two distinct phenomena.

Exchanges between laboratories in scientifically-important countries have always been perceived as fundamental to science of the highest quality. Typically, they took place at the postdoctoral level, on a relatively small scale, and were largely limited to the best individuals and laboratories. Colleagues in two countries, familiar with each another's work and laboratories, try to arrange a fellowship that will allow a promising new PhD to work in the other country. In recent years, as a number of countries have sought to enhance the international orientation of their scientific institutions, special exchange funds have often been established. These can be "tapped" by young scholars seeking to do advanced work abroad. To some degree, recent developments represent a formalisation and an extension of existing scholarly contacts. The Network Programme of the European Science Foundation, which began in 1985, provides a structure to facilitate the creation of disciplinary networks of this kind. The purpose of these networks – of which there are now 22 – is to bring European scholars together to foster mutual awareness, promote mobility, and expand collaboration. Many of these networks specifically provide facilities for postgraduate researchers (*e.g.* summer schools).

The second phenomenon is rather different, deriving more from the training than the research function of universities. A number of OECD countries have for many years played host to very large numbers of postgraduate students from abroad. The reasons include the quality of the training offered, historical ties between nations, or geographic proximity. The consequence is that these few countries award substantial proportions of PhD degrees to non-citizens.

In the United States, for example, 24 per cent of 1991 PhD recipients were not US citizens. There are, however, great differences among disciplines; the figure is as high as 47 per cent in engineering and 35 per cent in the physical sciences, but only 16 per cent in the social sciences. In Australia, 21 per cent of all PhD recipients were from abroad, again with a much higher percentage (46 per cent) in engineering. In both countries, a significant majority of these PhDs are from Asia (69 per cent in the case of Australia). In France, 35 per cent of doctorate recipients are from abroad (Faasse, 1993). These figures suggest that technical assistance to countries with which the host country has historic or geographic ties are an important factor.

As a result, research training programmes, particularly in the technical disciplines, can become very dependent upon the flows of foreign students. One recent study has shown how important overseas postgraduate students can be to the continuance of specific university programmes in France. According to another study, "For smaller departments, overseas students, despite their often inadequate qualifications, were the sole means not simply of keeping up numbers but also of preventing the withdrawal of

validation for DEA programs and ultimately, the disappearance of doctoral work" (Neave and Edelstein, 1993, p. 212). In the United States, this dependency has been signalled as a problem at the national level.

As mentioned at the outset, the international dimension is becoming both more complex and more important. As governments come to focus on research training as a significant policy issue, they seek to give more explicit direction to international exchange and mobility. The distinction between the two historic forms – one emerging from the scientific community, the other from the international dimension of higher education – are becoming blurred.

The most notable development in the area of internationalisation is the attempt to radically strengthen and dramatically extend ties of these kinds within the context of European integration. European Union programmes such as the Human Capital and Mobility programme represent an attempt to enhance the quality of graduate training within this specific socio-political framework. Current concern with internationalisation is not only motivated by ideas of quality and efficiency in the use of scientific resources. Political and economic reasoning plays an increasingly important part, as governments seek to respond to the new "co-operation networks and strategic alliances" of "high-tech" industrial sectors (Science and Technology Policy Council of Finland, 1991). When the French Ministry of Education refers to the desirability of initiating a European DEA or DEA courses that are European in content and spirit, the underlying concern is with the changing structure of Europe.

In line with this recent aim, the de Wied Committee was specifically asked to look into the possibilities for further international collaboration among the participating countries at the level of research training. A number of its recommendations were specifically directed to this end. Most particularly the Committee supported "the current tendency to channel scientific exchange and mobility in line with moves towards European integration. The gradual shaping of a European scientific and technological community, with roots into the education system, is a significant step in a process of gradual economic and social transformation." It also argued that the networks, structures and resources for mobility being created should be extended carefully into Central and Eastern Europe [the Partners in Transition (PIT) countries]. "The Europe now emerging will soon come to encompass a number of countries in Central and Eastern Europe. These countries make clear their urgent need for assistance in the training of a new generation of university teachers [see the Czech case study on this point]. Meeting this need, a task with implications for the scale, organisation and finance of graduate research training as well as for further internationalisation, is one which has clearly struck many a chord in Western European academic institutions.[2] It is necessary to proceed determinedly but thoughtfully, if the very real danger of a massive brain drain is not to be further exacerbated." In central and eastern European countries themselves, priority is attached to the training of university teachers (who would themselves train future practitioners in line with national needs); to integration of scientists into the Western scientific community; and to the introduction of Western standards of assessment and performance. These priorities obviously require response particularly at the level of postgraduate research training. A further point made by the de Wied Committee concerns the need for disciplinary communities to retain control of the development of initiatives. These points were strongly

endorsed at the meeting of representatives of scientific organisations that took place in Amsterdam in October 1993, at the initiative of the Dutch Minister of Education and Science.

These issues have been addressed by two initiatives of the French government. In 1992 the French Ministry of Education introduced the idea of "double supervision", by which a doctoral dissertation would be submitted simultaneously to a French and a foreign university, on the basis of research carried out in the two countries. For agreements with universities in Central and Eastern Europe in this framework, funds in support of this initiative are made available by the Ministry of Foreign Affairs. The second scheme allows for senior professors to spend six months a year in France for three years, with the obligation to return to their country of origin.

The risks inherent in decoupling exchange schemes from professional relationships, even at the undergraduate level, have recently been pointed out. The implications of this analysis are important for any ERASMUS-like scheme specifically aimed at postgraduate mobility:

> "... we may assume that the character of study abroad in Europe would change dramatically if the ERASMUS programme did not predominantly stimulate co-operation between departments rather than co-operation between the central levels of universities. In the latter case, we could predict that administrative refinements, the aims of cultural and personality development, 'cafeteria' – like concepts, etc., would gain more popularity at the expense of emphasis on academic goals and curricular integration." (Teichler, 1990.)

Despite the growing commitment at both national and institutional levels to the internationalisation of research training, major barriers remain. They derive in part from differences in the resources available in different national university systems. One institution may find that it cannot fund participation by its students or trainees at the level agreed or thought desirable by its international partners. Other issues affect the readiness of individuals to travel. Changing life styles may be posing increasing barriers to mobility. Compare the following two stereotypes. On the one hand, there is the research student wholly committed to preparation for a life of science, wishing to take maximum advantage of the years of training with which he or she has been provided, and anxious to grasp all possible opportunities. Against this, the modern research trainee is very likely to be committed to a partner who is also trying to make a career, there may be children whose schooling cannot easily be disrupted, and there may be roots in the local community. In addition, adequate housing often cannot be guaranteed in the designated city.

Many studies have highlighted the difficulties encountered by students from abroad, especially those coming from significantly different cultures, and who may have expectations wholly at variance with usual practices in the host country. Problems derive not only from loneliness and differences in life style. Manners of teaching and learning, cultural traditions for the presentation of evidence and argument, excessive "distance" between student and supervisor due to non-Western cultural norms of age and status – all these may trouble the student's experience of advanced study abroad.

Conclusions

Policies specifically addressing the form and content of doctoral research training are emerging for the first time in a number of OECD countries. In other countries, existing structures are being radically reconsidered. The background to these initiatives is complex and reflects a number of changes taking place in the research systems, in higher education systems, and in the expectations both of the economy and society. Of particular note among these changes are a reconsideration of the location of research and a questioning of the privileged status of the university as the principal locus of frontier research; the "massification" of higher education, which entails a rethinking of traditional educational practices and curricula; the changing relations between research training and the labour market; and internationalisation, in part for reasons of enhanced quality and assistance to less favoured regions, but above all with the goal of a more integrated European scientific community. As described in the de Wied Report, these considerations are resulting in the emergence of new structures for research training, roughly modelled on the American idea of the graduate school, in a number of countries. They are also resulting in some rethinking of the function and objectives of research training and of the PhD degree (or its equivalents).

This rethinking of functions and objectives is linked to the idea of decoupling the PhD from what, in the majority of OECD countries, has been its traditional function: preparation for a career in academic research and teaching. PhDs, policy-makers are increasingly claiming, must be prepared for a wider variety of social functions, including, of course, careers in industry. The result is a growing emphasis on transferable research skills, so that the quality of the training should be assessed less than in the past in terms of the originality of the contribution to knowledge which a dissertation represents, and more in terms of mastery of a body of research skills. Research topics should also be less "esoteric", that is, more relevant to the problems of economic and other institutions.

These views are far from universally shared. On the one hand, the new structures emerging – which require built-in controls of quality (*e.g.* of supervision) – seem to some to represent a challenge to traditional notions of academic freedom or authority. This is an area in which academic institutions are notoriously conservative. The arguments for vesting responsibility for research trainees (including PhD students) in the institution, rather than allowing it to remain under individual (professorial) authority, seem overwhelming. Traditional patterns of individual apprenticeship, whatever their benefits for the very best students and teachers, are no longer adequate to the expanded scale of postgraduate training or to new notions of "consumer rights".

The second set of objections, voiced particularly in the social sciences and humanities, concerns changing notions of what "good" research training should mean. The argument here is that by emphasising research skills rather than originality, the overall quality of university research will fall dramatically. Since research students conduct the bulk of university research, any shift away from emphasis on the quality of the product (the dissertation) will result in an overall output of science which is simply less good. There are two arguments here, and they are often confused. On the one hand, there is strong evidence for the value of better preparing the PhD student in the methods of

research. This is an important reason for introducing a preliminary year to be marked by the award of an intermediate qualification. This does not necessarily mean that subsequent dissertation work should be judged any less than in the past in terms of its originality and scientific contribution. In any event, it is probably necessary to give more thought to criteria and procedures for assessing the quality of research training, however conceptualised.

Emphasis on formal skills is of course bound up with the notion of preparing PhDs for non-university functions. It is clear, however, that with the exception of the United States, labour markets for PhDs scarcely exist in OECD countries. Economic demand is small and highly specialised. The policy response is typically limited to an insistence on more "relevant" dissertation topics. That is, the problem is felt to inhere totally in the structure of, and values inherent in, PhD training. Though an academic career remains the principal objective of most students embarking on PhD training, and though their knowledge may ultimately be rather specialised, these factors are probably only part of the reason for the mismatch. Thought must also be given to the demand side and the attitudes which underlie it. How adequately are PhDs in fact used outside the university? There are powerful arguments for developing initiatives designed to enhance both the non-research skills needed for employment (flexibility, motivation, communicative skills) and the sense among employers of what highly-trained young scientists have to offer.

In the United States, at least, a significant proportion of the nation's PhD holders do obtain non-university employment. Yet it must be recognised that in the United States, especially in the natural sciences, the PhD degree is no longer seen as the endpoint of research training. A shift in the function of the PhD has been accompanied by the emergence of a subsequent stage (postdoctoral training) in which the traditional function – preparation for a career in university teaching or basic research – is now vested. The lesson of the US experience is being learned inadequately and partially. The emergence of postdoctoral positions on any scale is a recent phenomenon in other OECD countries, with the partial exception of other English-speaking countries. Yet it seems that this is an essential complement to the changes in PhD training now being discussed if the universities are to be able to continue to fulfil their functions in research performance and in the reproduction of the scientific community.

Notes

1. In a number of Member countries, special booklets on "good supervisory practice" have been published. The model was *Research Student and Supervisor*, Science and Engineering Research Council, 1982. Others have since been published by the Council of Graduate Schools in Washington, DC, and the Canadian Association for Graduate Studies.
2. For example, the programme being developed between the University of Tromso in northern Norway and the relatively nearby University Arkhangelsk in the Siberian Republic of the Russian Federation.

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Chapter 1

RESEARCH TRAINING IN AUSTRALIA POLICY, PRACTICE, AND DIRECTIONS IN THE 1990s

by

Tim Turpin and Sue Curtis

The Centre for Research Policy, University of Wollongong

Introduction

As in most OECD countries, the university system in Australia has undergone considerable change during the past decade. First, it has expanded rapidly and significantly. Total numbers of students in higher education increased by 56.6 per cent between 1982 and 1991 (from 341 390 students in 1982 to 534 538 in 1991). The rise was greatest for female and full-time students. Second, the Australian separation of universities from colleges of advanced education and institutes of technology, which prevailed from 1965 to 1988, has been abolished, thereby creating a new unified national system (UNS) of higher education. Australia's 19 universities and 42 colleges and institutes have been transformed, rapidly and with little opposition, into a system of 34 universities and two university colleges. Negotiations for other mergers are proceeding, while at least one previous merger is in the process of redividing into two separate institutions. Third, government policy is steering universities towards become more selective in their research and teaching priorities, concentrating resources in selected areas, and relying more on non-government sources for funding. As one result, most universities, and particularly those with the highest growth rates, are moving towards more vocationally oriented degrees. This trend is consistent with the experience of many other OECD countries (see, for example, McNay, 1992).

These changes have, however, left the basic university degree structure and the requirements for student advances relatively unchanged. The basic undergraduate curriculum at most universities is still a bachelor's degree of three or four years' duration. In 1991, over 71 per cent of all higher education enrolments were in courses of this type. Further, the usual entry requirement for a bachelor's degree is still typically successful completion of a 12-year high school certificate. The bachelor's degree can be followed by a master's degree and a PhD. A master's degree can be acquired through course work

accompanied by a dissertation or through a research thesis alone. Pressures to broaden the concept and structure of the PhD are increasing, but so far no PhDs through course work are awarded. However, although the formal degree structure for research training has changed little, policy and structural changes in the higher education system have still had a significant impact on research training throughout the country.

Increased student enrolments for higher degrees and increased emphasis on vocational courses at these levels are leading to growing demands to extend doctoral programmes into areas specifically related to industry. Government support for students studying for higher degrees has shifted during the 1980s from schemes for providing student support towards schemes intended to attract the most promising students to research careers.

At the same time, research in universities is moving away from traditional departments and towards multi-disciplinary problem-oriented research centres. During the 1990s, these are likely to serve as an ever more important training ground for research students and a source of employment for graduates. Already, research centres within the university system are providing funds that "top off" government scholarships to make them more attractive to potential research students. Research training in Australia is therefore likely to become increasingly oriented towards answering questions raised by broader social and economic issues rather than those raised by the traditional scientific disciplines. This trend may also foreshadow a growing separation between undergraduate teaching and research.

Current issues in higher education

The restructuring of higher education in the 1980s

Australian higher education institutions are self-governing bodies which are, in most cases, established under state legislation. They are predominantly funded by the Commonwealth government and, except for Australia's two private universities and a small number of specialised colleges, most of which are arranging affiliation with universities in the unified national system, they form a centrally co-ordinated unified national system.

During the past decade significant challenges and pressures for change have emerged. As noted above, both student numbers and the total number of universities, so defined, have almost doubled. Other pressures have included the greater diversity of the student population, political and industrial pressures for a more skilled work force to maintain and enhance economic standing, academic demands for critical inquiry and cultural regeneration, and the growing internationalisation of higher education in general. The government's articulated policy goals (Dawkins, 1988 and 1989) throughout this period of change have emphasised the following objectives: providing additional places for university students; enhancing the total research capacity of the system; identifying national goals and priorities; striking a balance between pressures for change and the strengths of tradition; maintaining and promoting diversity of strengths and aspirations

among various institutions; making more efficient use of national resources; establishing closer links between academic activities and the social and economic needs of Australian society.

As one consequence of institutional mergers, smaller institutions have now been combined with significantly larger units. In some cases, institutions with different teaching and research cultures, different objectives, and different disciplinary histories have been joined (Marsh and Turpin, 1992). Also, many previously non-degree courses of study, such as nursing and paramedical services, are bachelor degree programmes. Further, the university system has become considerably more competitive and more dispersed throughout the country than it was a decade ago. Government policy has required institutions to become more selective in the areas that they identify as research strengths. All institutions within the new UNS must now produce a Research and Educational Management Plan, identify their research and teaching strength and develop a management strategy to promote these particular strengths. Funding mechanisms are tied to the objectives identified and to institutional success in attracting funds, from both government and industry, to support those objectives. This policy has led institutions to distribute their limited research funds to areas of perceived research strength rather than to individual researchers (Murphy and Hill, 1992).

Research centres in Australian universities

The government policies of selectivity and concentration have resulted in the formation of a variety of types of research centres throughout the academic system. In order to promote research excellence, a programme of Special Research Centres was commenced in 1982, followed, in 1985, by the Key Centres of Teaching and Research. At present there are 26 of the former and 31 of the latter, funded by the Department of Employment, Education and Training.

In addition, the government has introduced a programme of Co-operative Research Centres (CRCs). These centres are intended to strengthen the links between academic research and industry through formalised partnerships between universities, government research institutes, and industrial enterprises. A total of 50 CRCs have already been selected for funding (Liyange *et al.*, 1991; Liyange and Mitchell, 1992). The government has now added a fourth programme that will establish up to six national centres for engineering innovation (Free, 1992).

The development of research centres, however, has gone well beyond these centrally-funded structures. Universities have sought to establish them for a range of reasons: to attract additional and increasingly scarce research funding, to develop "team" strengths for attracting external collaboration, to provide a focus for various faculty strengths, or to provide a training ground for new and promising researchers to gain experience and prove their worth. The result has been a growing number of research centres that cross disciplinary, faculty, and institutional boundaries.

In 1992, over 800 such research centres had been formally established in Australian universities. At present, they account for some 50 per cent of total university research effort. They are increasingly providing training for research students at both the master's

and the doctoral level. The only study carried out to date suggests that they are emerging as a major challenge to the departmental structures that have dominated research training in the past (Marsh *et al.*, 1992). In terms of establishing linkages with industry, the impact of these centres has yet to be assessed, but they are likely to continue to play an ever greater role as a training ground for postgraduate research students.

The importance of these centres as a training ground and as a potential employer of research graduates is considerable. As Sheehan has pointed out (1993), two of the greatest benefits of the CRCs have been in "presenting postgraduate students with 'real life' industrial challenges – and the chance to use the Commonwealth Science, Industry and Research Organisation (CSIRO) and other science agencies' staff in the teaching process". A recent Australian study on research training strongly emphasises creating "appropriate educational learning environments" and "collaborative groupings with academic staff and students", and sharing facilities. The same study compares the effectiveness of different supervisory models for the social sciences: the workshop, the directed team, the conference, and the methodology group. It argues that these models are effective for group-based research training and that the results suggest they provide practicable models for other fields of study. (Moses, 1992, pp. 46-47.) The emphasis on group supervision and oriented study is consistent with, and indeed supports, the general trend towards centre-based structures as an alternative to the more traditional disciplinary structure of university departments.

The past few years have also seen a greater tendency towards making research training more coherent at the national level. In the fields of economics and agriculture, industry has funded national PhD workshops in order to bring together research students and supervisors from a number of universities to share expertise and research findings. While students receive no formal credit for attending these sessions, such workshops have the potential to help improve coherence of learning methods and help orient practical research.

The recently formed STEP (Science, Technology and Socio-economic Progress) programme offers an example of this emerging form of collaborative research training. It is a national network established for research students engaged in studies of science and economic policy. The programme has received government seed funding for three years and brings together students from many Australian universities and a wide range of disciplines. It serves as a training ground for students as well as a forum for presenting and exploring research findings in the context of current industrial and government research problems. In 1993 the programme received a share of its funds directly from industry.

Diversity in higher education and the quality debate

The recent changes in Australian higher education have raised some heated debate concerning the quality of the university system. Key themes in the development of higher education policy within Australia have been issues of managing growth and maintaining participatory equity and maintaining quality within increasingly diverse programmes of study (Baldwin, 1991*a*, p. v).

The quality debate, documented in government reports, policy statements, and the popular press, provides an overview of Australia's attempts to come to terms with its goals for, and what it values in, higher education. Policy statements of recent years all include, in one form or another, the themes of enhanced efficiency in the use of resources, improved quality of research training, matching of human resources to national priorities, and the need for internationalisation (OECD, 1991). Major policy shifts have framed this debate and provided the emerging agendas to which the educational system's various interest groups have responded.

With respect to quality, the trend in government publications has been to move away from its earlier focus on accountability and towards better management as a principle for all groups with an interest in higher education. As the Australian Vice-Chancellor's Committee (1992) recently observed, "[with] the new Australia, which is evolving agonisingly but visibly from the national restructuring programme, the search for quality in every field of endeavour has to be a constant preoccupation". From a different standpoint, most institutions have devised codes for sustaining and monitoring academic quality and standards for higher degrees. Both the Australian Vice-Chancellors' Committee (AVCC) and the Council for Australian Postgraduate Associations (CAPA) have produced guidelines for maintaining standards of quality. These have been adapted and adopted by most Australian universities, a move which has served initiatives concerned with quality in postgraduate education. On the other hand, despite the existence of formal guidelines, variations in supervisory practice continue to dominate most discussions of research training and are perceived as a general and widespread problem across all institutions (Sheehan, 1992).

Quality imperatives for development

The quality debate in higher education is part of a much broader movement in industry and services that is aimed at strategic development for competitive advantage. One of the key themes in higher education's contribution to the debate has been the preservation of the autonomy of institutions of higher education. As the Chairman of the AVCC noted recently (McKinnon, 1991): "The best way to ensure quality was by jealously guarding the present autonomy to create your own curricula and to keep in touch with world excellence in the field." A view widely shared among Australian vice-chancellors is that quality is about difference: each institution needs to have its own measures, and quality controls for a system largely based on research must be very different from those of a system largely based on skills (Gayle, 1991).

A closely related theme concerns the framework for making quality judgements. An earlier Commonwealth Tertiary Education Commission report noted, somewhat cautiously, that "empirical measures of research and development activity must be treated with greater caution[,] ... underlying assumptions must always be made explicit[,] ... the "rules" of academic advancement [must be] more clearly defined and the bases on which they are applied ... [must be] interpreted with common understanding and thereby achieve acceptance" (1984, pp. 59-60).

The delicate balance between autonomy and accountability is increasingly being addressed through the concept of quality management for the system as a whole and quality assurance as a key development principle. The recent Australian government publication, *Higher Education: Achieving Quality* (1992*a*) refers specifically to the development of a national structure for quality assurance.

Higher education in Australia has always ensured quality through mechanisms such as peer review, publication in international journals, the critical review of disciplinary practices and products by the relevant international community of scholars, and the ability to attract research funding. Similarly, its attention to course reviews, staff development, student evaluation of teaching, and employer acceptance of graduates has maintained ongoing self-critical review and development. The relation between research programmes and research training is likely to become more important as changing structures give greater weight to research/research training linkages. While the concepts of "total quality management" and "quality assurance" have only recently entered the discourse of academic communities, they are likely to be increasingly used. Although quality assurance and academic review may appear to be rather different, they have, in practice, common principles. It is very likely that the need for mechanisms that facilitate synergy between "autonomy" and "accountability" will encourage moves towards some form of total quality management.

In seeking to come to terms with issues of quality, recent government publications have incorporated various frameworks and employed indicators that reflect the key issues confronting the government and serve as functional correlates of quality for higher education (see Table 1.1).

Table 1.1. **Functional correlates of quality in policy documents, 1984-92**

	Report	Functional correlates of quality
1984	Linke Report[1]	Efficiency
1987	ASTEC Report[2]	Value (for money)
1988	Dawkins White Paper[3]	Efficiency, effectiveness, accountability
1989 (May)	Dawkins[4]	Excellence through and concentration
1989 (July)	HEC Report[5]	Flexibility, diversity, responsiveness, efficiency
1991 (October)	Baldwin[6]	Diversity
1992 (February)	HEC[7]	Outcomes for stakeholders
1992 (July)	HEC[8]	(Re)assurance for stakeholders
1992 (October)	HEC[9]	Quality management for stakeholders

1 Commonwealth Tertiary Education Commission, 1984
2 ASTEC, 1987
3 Dawkins, 1988
4 Dawkins, 1989*b*
5 Higher Education Council, 1989
6 Baldwin, 1991*a*
7 Higher Education Council, 1992*b*
8 Higher Education Council, 1992*c*
9 Higher Education Council, 1992*a*

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In the context of this debate, postgraduate and research training issues are attracting considerable attention. The Council of Australian Postgraduate Associations (CAPA), for example, has expressed concern that the "monitoring and measurement of quality . . . [sho.ld] not be an end in itself, but a means of gathering information showing ways in which the education environment can be altered so as to enhance "learning" (Higher Education Council, 1992*b*, p. 56). The Council warns of the dangers it sees in using simple "product" indicators for judging quality assurance. It advises that this can be both problematic and inappropriate. It also warns that if attention is not paid to providing quality learning environments for postgraduate students, learning will be impoverished.

Quality initiatives and postgraduate education

In a recent report, the government defined the range of stakeholders in higher education as academic staff, students, administrators, employers, governments, the community in general, professional associations, and the international research and scholarly community. This view, in combination with emerging "opportunities for focus and balance of graduate and higher degree study" (Higher Education Council, 1989, p. ix) has significantly enhanced options for research training (Higher Education Council, 1989, Chap. 3). The postgraduate students' association, however, has indicated that although postgraduate education has been reshapen, taken on new roles, and incorporated various degrees and course work, it may still be too narrowly conceptualised. It points out that, although the data show a different picture, the overriding view of postgraduate education is an activity involving "young, single males engaged in full-time research" (Higher Education Council, 1992*b*, p. 57). As the association noted, many postgraduates today are much older, professionally competent, and experienced. In this case, the student/supervisor relationship will have to be quite different from the traditional "master-apprentice" system, if it is to be productive and satisfying to both parties concerned.

The government has articulated concerns for enhanced learning for students and, in the context of serving the interests of a diverse Australian community, for enhanced "life chances" for students and graduates. There is a significant move towards mechanisms such as "open learning" through multimedia facilities and distance education. A review of the means of delivering higher education has been initiated, so that full advantage can be taken of developments in information technology (Baldwin, 1991*a*, p. 7). The Higher Education Council (HEC) places such goals, however, within the broader context of a need to demonstrate the specific place and contribution of individual institutions in the national and international communities (HEC, 1992*a*, pp. 10-11).

The HEC's *Achieving Quality* (1992*a*) develops this theme as it synthesises the debate on quality and sets out the way forward. The HEC emphasises that students must acquire generic skills, attributes, and values, owing to the ever-diminishing "intellectual half-life" of any particular body of knowledge. The Chairman of the Australian HEC has stated quite clearly (Chubb, 1992) that, in the Council's view, the issue of quality means international comparability: "A graduate from an Australian university ought to be able to operate anywhere at a professional level consistent with the best in the world. That's our ambition as a nation for the graduates of our university system." A recent HEC draft

report has concluded that the system is trying to spread too little money too far and is creating false expectations in the former colleges which have recently moved into post-graduate education at a rate incommensurate with their infrastructure.

In general, however, emphasis on the quality of learning environments, particularly those of postgraduate students, has increased. The AVCC has produced a formal code of responsibilities for supervision of postgraduates. It has encouraged all institutions to develop their own local variants, but in doing so has provided a word of caution:

> "The development of 'codes' that lead to the explicit recognition that research students are undergoing a period of research training, however, does not mean that the process of 'osmosis' will on its own develop in the students the insights and skills ... necessary for the pursuit of a successful research career." (HEC, 1992*a*, p. 43.)

The Higher Education Council's submission to government has proposed a number of strategies for achieving quality in higher education. These strategies are suggested as a means of encouraging the higher education system to maintain and improve the quality of higher education, as well as a means to monitor and evaluate changes in quality over time. Central to the strategies suggested is a recommendation to adopt a representative national structure for quality assurance in higher education. This recommendation is part of a framework of system-wide, strategic quality management principles for future progress. It is in this context that future developments in research training and postgraduate education for Australia are likely to be framed.

Most universities in Australia have produced supervisors' guidelines and general agreements on what constitutes good supervisory practice. The Council of Postgraduate Associations has repeatedly pointed out that such practices are critically important for research training but that increasing diversity in the student population – off-campus (external) students, part-time students, industry-based students, and overseas (foreign) students – will require different forms of supervision. It seeks to introduce measures to monitor the practice of good supervisory guidelines and to ensure accountability of supervisors to increasingly public codes of practice (Sheehan, 1992, p. 5).

Finally, with the quality debate firmly on the agenda for the 1990s, the option of developing graduate schools as a means of maintaining quality and consistency throughout the unified system is receiving renewed interest. In 1990, the Australian National University established a graduate school which spans the university's two internal structures (the Institute of Advanced Studies and the Faculties). The school aims to enhance the quality of graduate education, to augment the number of graduate students, to improve the "pastoral care" offered to students, and to make the university a more attractive place for graduate study (Spear, 1992). As the distance between university research concentrations and general undergraduate teaching programmes widens, graduate schools are likely to become a widely-discussed management option for other Australian universities.

Course structures and student enrolments in higher education

In 1991, 534 538 students were enrolled in Australian universities and colleges. The trend in enrolments has been towards full-time study. In 1982, 53 per cent of all students were full-time students, compared to 61 per cent in 1991. Off-campus (external) students have remained constant at around 11 per cent of all enrolments. The proportion of women students grew from 46 per cent of all enrollees in 1982 to 53 per cent in 1991. In 1991, women participated in higher education at a rate of 48 per 1 000 overall Australian population, and men at a rate of 44 per 1 000.

In 1991, the majority of higher education students in 1991 were enrolled in a bachelor's degree programme (380 590, or 71 per cent). Just over 17 per cent (92 903) of all enrolments were for postgraduate degrees, a figure broadly comparable to the just over 16 per cent for 1982. In 1982 18.3 per cent of all enrolments were for non-degree courses, against 11.4 per cent in 1991. The trend has therefore been towards degrees and, less significantly, towards higher degrees (see Table 1.2). Recent projections for the period to 1994 predict a decline in the proportion of students enrolled in bachelor degree programmes, which will be offset by increases in course work and research for higher degrees (McNicol, 1992). This projection is consistent with funding allocations for higher education. Allocations for 1993 have allotted 44 per cent of the total additional funded intake for postgraduate places and 56 per cent for undergraduate study (Baldwin, 1991*b*, p. 22). This suggests that the trend towards higher degrees, and higher degrees through research in particular, will continue to increase.

There has also been a trend away from off-campus (external) study (10.6 per cent in 1991 compared to 11.9 per cent in 1982). Approximately 61.5 per cent of the total student population were full-time on campus (internal) students. However, over the next decade, Distance Education Centres are likely to change this trend again. These centres should provide for more effective and more consistent distance education, as the actual number of providers drops and the number of users rises.

Table 1.2 **All higher education students by level of course, 1982 and 1991**

Percentage

	1982	1991
Higher degree	7.3	8.3
Other postgraduate	9.1	9.1
Bachelor	65.3	71.2
Other courses	18.3	11.4
Total	100.0	100.0

Source: Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1992, Table 1

The Minister for Education predicted a national rise in off-campus study of 4 per cent during the 1991-92 period, with increases of up to 12 per cent in some areas. One university has already developed a national television programme to broadcast postgraduate lectures and is developing a national resource for postgraduate distance learning. These developments should be considered in the context of Australia's disproportionately urban student population. In 1991, 79 per cent of all students were from urban areas, whereas only 71 per cent of the total population live in urban areas.

Fields of study

Table 1.3 shows the proportion of students enrolled in Australian universities, by field of study, for the years 1983 and 1991. Student concentrations in the arts, humanities and social sciences have decreased during the past decade. The same trend is particularly noticeable in education, which fell from 21.3 per cent of all enrolments in 1983 to 14.9 per cent in 1991. Medecine and health show the greatest growth, and science remains constant. In a recent study, the Australian National Institute of Labour Studies developed a model for predicting growth rates for different fields of science from 1990 to 2001. The high-growth scenario in this model predicted an overall annual increase of 3.2 per cent a year. The greatest predicted increases were in administration and business courses (3.9 per cent a year); engineering and processing, mathematics and computing (3.7 per cent); and sciences and health (3.6 per cent). The lowest predicted growth rates were for education (2.3 per cent), humanities (2.4 per cent) and visual and performing arts (2.3 per cent) (Sloan *et al.*, 1990).

Table 1.3. **Proportion of all students enrolled in higher education courses by field of study, 1983 and 1991**

Percentage

	1983	1991
Agriculture, animal husbandry	1.8	1.8
Architecture, building	2.2	2.1
Arts, humanities, social sciences	24.7	22.7
Business administration, economics	18.0	21.0
Education	21.3	14.9
Engineering, surveying	7.9	7.5
Medecine, health	5.6	11.6
Law, legal studies	3.0	3.1
Science	14.0	14.2
Veterinary science	0.4	0.3
Non-award courses	1.1	0.7
Total	100.0	99.9

Source: Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1991, Table 4.

Funding support for undergraduate students

Students in Australia are required to contribute to the cost of their education through a Higher Education Contribution Scheme (HECS). Under present legislation the student can choose either to pay the fee at the beginning of each semester or to defer payment, to be deducted from future earnings under the Australian taxation system. The second option, however, results in a higher overall contribution. When the HECS was introduced in 1988, the Australian Higher Education Council was charged with reporting annually on the impact of HECS on educational profiles. It is too early to make any clear judgements, but the most recent analysis suggests that it has had minimal effect (Dawkins, 1990). Evidence cited in support is the significant increase in enrolments since the scheme was introduced. The issue of access for all social groups is, however, still not clear.

Postgraduate research training

Overview

Formal postgraduate education essentially developed after World War II. The first Australian PhD was awarded in 1948. In 1956, the Murray Committee was charged with examining the organisation of Australian universities. Its report argued that Australia's self-sufficiency required the development of the research capabilities necessary to exploit the potential of Australia's environment and to contribute to development in the Pacific region. It recommended the establishment of a Commonwealth Postgraduate Research Award Scheme (CPRA) which was introduced in 1959. The specific aim was to develop postgraduate research schools in Australian universities, to maintain a flow of highly-trained personnel for the work force, and to promote the full intellectual development of the most talented students. As Hill and Johnston pointed out, it was introduced to support the birth and early growth of indigenous research capacity in Australia (Hill and Johnston, 1983). In 1971, a university-level master's degree obtained by course work was introduced, with the aim of upgrading the professional competence of skilled people in industry, commerce, and government. In 1974 a similar scheme was introduced in the College of Advanced Education (CAE) sector; it was phased out when the binary system was abolished.

Between 1959 and 1982, enrolments for postgraduate work and higher degrees rose from 2 226 to 24 630, and by 1991 they had reached 92 903. Enrolments for a higher degree through research went from 1 122 in 1961 to 7 021 in 1982, and to 10 960 by 1991. Table 1.4 presents numbers of postgraduate students according to major fields of study. The greatest concentrations are in education (27 per cent), business (19 per cent), arts (18 per cent), and science (13.5 per cent).

The traditional requirement for entry to a PhD programme in Australia has been four years of higher education with a demonstrated capacity for research, generally an honours degree. In a significant number of cases students complete a master's degree first. In

Table 1.4 **All postgraduate and higher degree students, by field of study, 1991**

	All students	Percentage
Agriculture	1 335	1.4
Architecture	2 046	2.2
Arts, humanities, social sciences	16 922	18.2
Business administrations, economics	17 459	18.8
Education	24 910	26.8
Engineering	5 698	6.1
Medicine, health	8 606	9.3
Law, legal studies	3 094	3.3
Science	12 572	13.5
Veterinary science	261	0.3
Total	92 903	99.9

Source Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1991

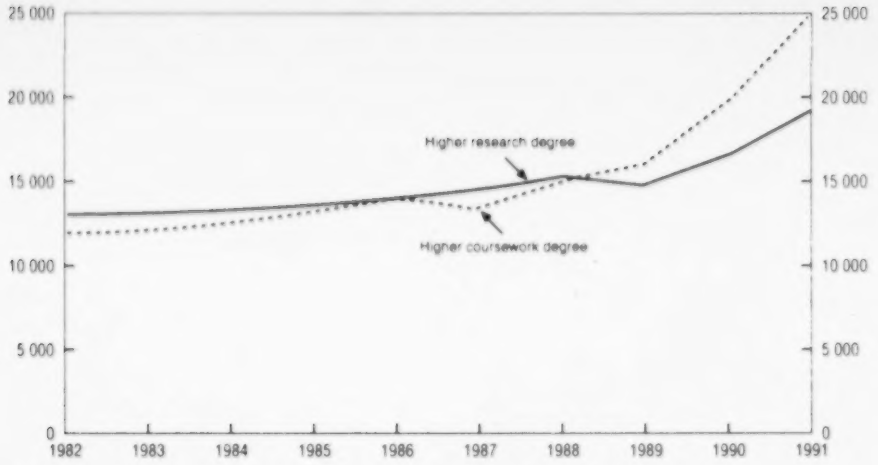
Australia all PhD degrees are research degrees. Master's degrees can be obtained on the basis of course work or research. Government-funded scholarships can be held for up to two years for a master's degree through research and for 3.5 years for the PhD. These awards are distributed in two phases. First, a quota, based on total enrolments in research higher degrees, is allocated to each institution (approximately 85 per cent of all awards). Awards are made on merit within that quota. Second-round offers are then made to institutions on the basis of the number of well-qualified students who did not receive first-round offers. Although the trend towards higher degrees has been rising over the past decade, the principal growth has occurred in higher degrees by course work. Figure 1.1 shows the comparative growth rates for the two forms of postgraduate training during the past decade. Yet the number of fully funded postgraduate research awards increased significantly over the same period (see Figure 1.2).

When the postgraduate award system was introduced in Australia in 1959, there were 2 274 enrolments and 100 stipends available. Thus, 4.4 per cent of postgraduate students were supported with direct government scholarships. By 1972 the proportion had climbed to 15.8 per cent. Although the total number of awards offered annually rose to 725 in 1983, the proportion of all postgraduate students supported through government scholarships dropped considerably (to 8.7 per cent in 1988).

Government postgraduate scholarships have always, however, been primarily directed to research students. The proportion of all full-time research students in receipt of Commonwealth awards increased from 17.9 per cent in 1961, reached a peak of 42.1 per cent during the early 1970s, and then declined to around 30 per cent during the early 1980s (HEC, 1989). In 1991, 23 per cent of all commencing postgraduate research students were supported by a Commonwealth award. The total number of research awards allocated during the past three years is shown in Table 1.5.

By the 1980s the Australian government was shifting the funding of research towards areas related to specific national objectives. A major study of the 1980s had

Figure 1.1 **Higher degree enrolments at Australian universities, 1982-91**



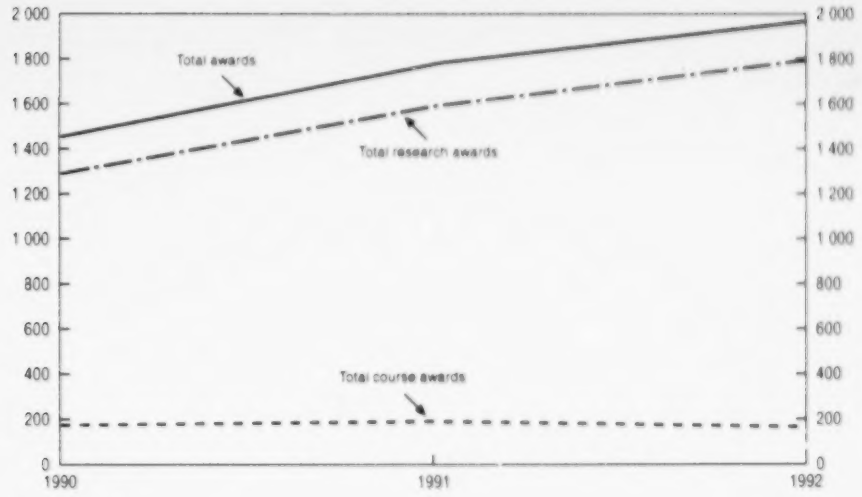
Source: Author.

argued that the allocation of awards tended to maintain an essentially conservative system based on past performance (Hill and Johnston, 1983). It also suggested that this created an employment barrier: in 1981, less than 6 per cent of higher-degree graduates, from all disciplines, entered the private sector, whereas in 1980 in the United Kingdom 29 per cent of PhD recipients entered the private sector. The study also warned against allowing labour market needs to play too great a role, owing to the time required to fill those needs.

In 1989 a review of the Australian Commonwealth postgraduate awards scheme introduced a range of recommendations, which included augmenting the total number of awards, raising the basic stipend, and introducing an industry-based award. The idea was to "move the research awards away from an image of student assistance to a system which recognises the value of the research contribution of postgraduate students and provides incentives to improve enrolments in strategic areas" (Australian Research Council, 1989, p. *iii*).

It was specifically recommended that the government scheme should cease to be administered under the Student Assistance Act and be administered by higher education institutions. The recommendation was accepted and came into force in 1990 for Australian Postgraduate Research Awards (APRA) and in 1991 for Australian Postgraduate Course work Awards (APCA) (Australian Research Council, 1991, p. 22). At the same

Figure 1.2. **Postgraduate awards, 1990-92**



Source: Author.

Table 1.5. **Current higher degree research student awards, 1990-92**

	1990	1991	1992
Australian Postgraduate Research Awards	864	1 006	1 190
Australian Postgraduate Research Awards to Institutions	50	78	79
Institutional Research Awards	382	512	512
Total Research Awards	1 296	1 498	1 812
Australian Postgraduate Course work Awards	136	162	149
Institutional Course Award	26	25	22
Total Course Awards	162	187	171
Total Awards	1 458	1 785	1 983

Source: Australian Vice-Chancellors' Committee, unpublished statistics, 1990-92

time, research centres with well-funded laboratories have begun to compete for the most promising students. Many offer funding in addition to government scholarships as added incentives.

Current higher degree by research enrolments

Current enrolments for higher degrees by research, according to field of study and sex, are presented in Table 1.6. These data show that nearly 28 per cent of all research higher degree students are enrolled in the sciences, a concentration significantly larger than for all students (14.2 per cent). In 1991, 22.6 per cent of all female and 30.8 per cent of all male higher degree research students were enrolled in the sciences. These levels are not being maintained, however, in current completions and enrolments.

Students commencing higher degrees by research field

A total of 6 965 students began research studies for a higher degree in 1992 across all Australian universities (Table 1.7). Approximately 25 per cent were enrolled in the sciences and 27 per cent in the humanities social sciences. When compared with data for all enrolled students in that year, the distribution shows a slight decrease in science and an increase in engineering and humanities/social science fields (see Table 1.8). It also indicates a trend towards a better gender balance, with greater participation by women across the sciences. Table 1.8 gives information on completing, commencing, and currently enrolled students for 1991. These data suggest that, in Australia, unless attrition rates drop, there may be a drift away from science in future years.

As a share of all research degrees completed, science has lost ground during the past five years (from 35.7 per cent in 1987 to 30 per cent in 1991). On the other hand,

Table 1.6. **All higher degree research students by field of study and sex, 1991**

	Males	Females	Total
Agriculture	573	218	791
Architecture	199	70	269
Arts, humanities, social sciences	2 495	2 635	5 130
Business administration, economics	610	279	889
Education	809	951	1 760
Engineering	2 053	243	2 296
Medicine, health	1 145	1 118	2 263
Law, legal studies	218	102	320
Science	3 706	1 658	5 364
Veterinary science	125	73	198
Total	11 933	7 347	19 280

Source: Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1991, Table 5.

Table 1.7 **Commencing students enrolled in higher degrees (research), by field of study and sex, 1991**

	Males	Females	Total
Agriculture	184	90	274
Architecture	77	37	114
Arts, humanities, social sciences	895	997	1 892
Business administration, economics	258	121	379
Education	319	355	674
Engineering	820	103	923
Medicine, health	349	402	751
Law, legal studies	9	47	138
Science	1 212	548	1 760
Veterinary science	33	27	60
Total	4 238	2 727	6 965

Source Department of Employment Education and Training, *Selected Higher Education Statistics*, 1992, Table 24

Table 1.8 **Share of higher degree research students completing, currently enrolled, and commencing studies, by field of study, 1991**

Percentage

	Completing	Current	Commencing
Agriculture	5.5	4.0	3.9
Architecture	1.2	1.4	1.6
Arts, humanities, social sciences	23.0	26.5	27.2
Business administration, economics	3.4	5.1	5.5
Education	7.1	9.1	9.7
Engineering	13.7	11.9	13.3
Medicine, health	12.9	11.6	10.3
Law, legal studies	0.9	1.7	1.9
Science	30.5	27.7	25.3
Veterinary science	1.8	1.0	0.9
Total	100.0	100.0	99.6

Source Department of Employment Education and Training, *Selected Higher Education Statistics*, 1991, Table 5

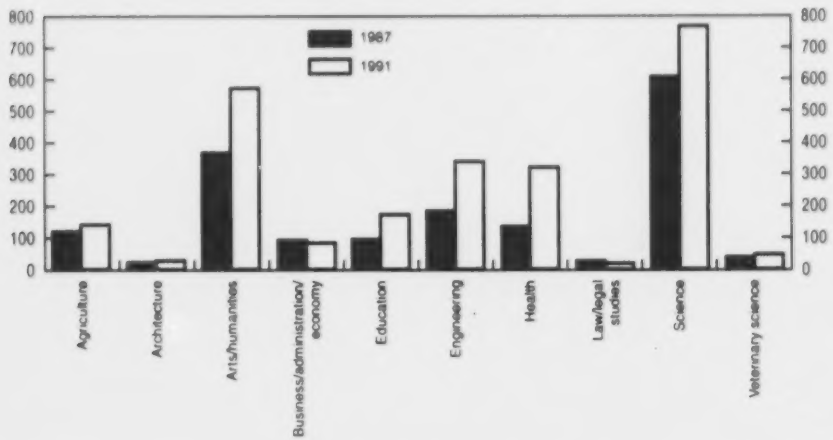
engineering moved from 11 per cent in 1987 to 14 per cent in 1991, while medicine/health rose from 8.5 per cent to 13 per cent over the same period. Part of the rise in medicine/health may be explained by the introduction of previous diploma courses such as nursing and physiotherapy to the university curriculum. Research degrees at the master's and PhD level in these disciplines are now being offered, at many Australian universities, for the first time. However, science is proportionately more significant at the

PhD level, with 36 per cent of all PhDs completed in 1991, as compared to 23 per cent of all master's research degrees and only 6 per cent of all master's degrees by course work. Just over 14 per cent of all bachelor's degrees completed in 1991 were science degrees. Further, 40 per cent of all master's degrees awarded in science were research degrees, against 30 per cent of engineering master's degrees and only 15 per cent of master's degrees overall. Thus, the sciences have a significant share of research training at the master's research and PhD level.

Completion of research degrees

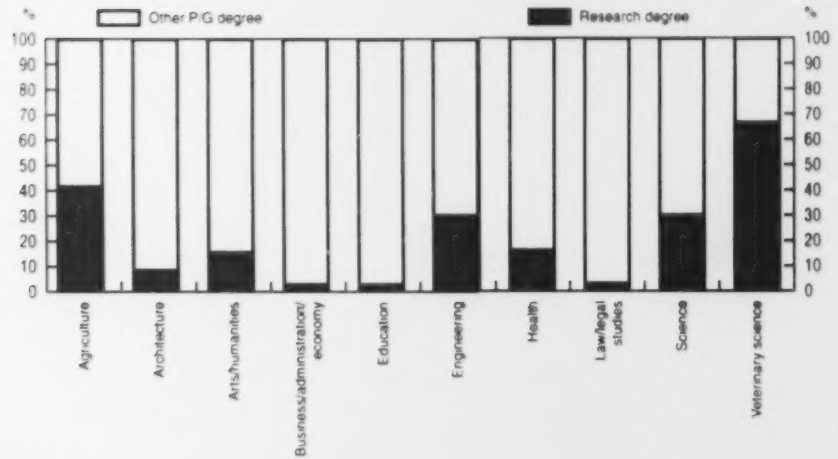
Changing patterns in student completion rates by field of study for 1987-91 are discussed below. Figure 1.3 shows completions of research higher degrees by fields of research for this period. All areas showed growth in absolute numbers, with the exception of law and business administration/economics. The greatest absolute rise was in the arts/humanities, and the biggest proportional rise in engineering and health. These data reflect the more vocational orientation of higher degrees by course work. As Figure 1.4 shows, completions in the fields of veterinary science, agriculture, engineering, and science are predominantly research degrees, whereas completions for other postgraduate degrees are concentrated in course work degrees.

Figure 1.3. **Research higher degrees completed by field of research, 1987 and 1991**



Source: Author.

Figure 1.4. **Higher degree completions by research and coursework, 1991**



Source: Author

Table 1.9. **Higher degree completions (research and course work), by field of study, 1987 and 1991**

	1987		1991	
	Research	Course work	Research	Course work
Agriculture	120	118	142	192
Architecture	22	202	31	362
Arts, humanities, social sciences	376	2 013	588	3 225
Business administration, economics	101	2 407	88	4 227
Education	95	7 548	182	8 910
Engineering	193	482	350	800
Medicine, health	147	787	330	1 696
Law, legal studies	27	931	22	902
Science	618	1 047	781	1 781
Veterinary science	34	14	46	22
Total completions	1 733	15 549	2 560	22 117

Source: Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1988 and 1992

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Table 1.9 shows the increase in completions of research and course work higher degrees since 1987. Completions have risen by 43 per cent overall and by 48 per cent in research. Thus, research higher degrees have consistently remained at just over 11 per cent as a proportion of all higher degrees.

In a recent and important Australian study, Sloan *et al.* (1990) defined completion rates as the proportion of students completing their course of study in a given year and calculated completion rates by field of study for both undergraduate and postgraduate degrees. Their data are presented in Table 1.10 and compared with the most recent completion rates available (1991). It is important to note that these data also reflect increases or decreases in entering students and that the lower completion rates shown for 1991 may reflect the general trend towards postgraduate training rather than attrition.

Attrition rates are represented here in what Sloan *et al.* have called "exit rates". These rates are calculated by comparing the stock of students in the previous year, less completions in the previous year, plus commencements in the current year, with the actual stock of students in the current year. Table 1.11 shows the exit rates for postgraduate research students for 1990/91. These data show a comparatively low exit rate for science (9.3 per cent), with the highest exit rates being recorded for law, agriculture, and architecture. It is possible that transfers may have distorted these figures to some extent, but it is unlikely that this would be significant at the master's and PhD levels.

Completed higher degrees by sex

In 1991, women completed 52 per cent of all higher degrees, an increase of 2 per cent over 1987. However, the gender balance varies considerably in different fields of study. Men dominate the fields of architecture, engineering, business administration, and

Table 1.10. **Completion rates by field of study and level of course at Australian higher education institutions, 1988 and 1991**

	All higher degrees 1988	All higher degrees 1991	Research higher degrees 1991
Agriculture	32.9	25.0	18.0
Architecture	20.9	19.2	11.5
Arts, humanities, social sciences	26.8	22.5	11.5
Business administration, economics	25.5	24.7	9.0
Education	46.2	36.5	10.3
Engineering	21.8	20.2	15.4
Medicine, health	25.6	23.5	14.6
Law, legal studies	52.0	29.9	16.9
Science	24.0	20.4	14.6
Veterinary science	25.0	26.1	23.2

Source: 1988 figures: Sloan *et al.*, 1990; 1991 figures: constructed from Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1988, 1991

Table 1.11. **Exit rates of higher degree research students by field of study, 1991-92**

	Exit rate
Agriculture	27.1
Architecture	23.2
Arts, humanities, social sciences	13.6
Business administration, economics	3.1
Education	9.7
Engineering	18.7
Medicine, health	11.2
Law, legal studies	30.4
Science	9.3
Veterinary science	5.8
Total overall	12.3

Source: Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1990 and 1991.

science, whereas women tend to dominate in education and health and, to a lesser degree, the humanities. Women have held or gained ground in all fields of research, but have shown the greatest share increases in health, education, and business administration. However, their advantage in some research fields is dramatically reduced for higher degrees by research.

Table 1.12 gives the proportion of women who completed higher degrees for the years 1987 and 1991 by level of degree awarded. In 1991 only 33 per cent of all higher degrees by research were awarded to women. However, the data indicate a rising trend: as Table 1.12 shows, women gained ground in all fields of study except business and administration.

The extent of the trend towards a more equitable gender balance among the population in higher degrees becomes more striking when these data are compared with data on the levels of qualification for the total population. According to the 1986 census in Australia, only 25 per cent of all higher degrees were held by women. This share will grow significantly over time if the current rate of higher degrees awarded to women is maintained (52 per cent). Similarly, women have only 28 per cent of the higher degrees in medicine/health in the total population; this contrasts sharply with the present share of female completions at 68 per cent.

Overseas (foreign) students

Overseas students constitute 6.1 per cent of the total Australian student population in higher education. The majority are from the Asian region (69 per cent); only 1.7 per cent of overseas students are from European countries. In 1990, 21 per cent of all research degrees were completed by students from overseas, compared to 26 per cent in 1987. The greatest concentration of overseas students is in engineering and science. Nearly 50 per

Table 1.12. **Proportion of women completing higher degrees by field of research, 1987 and 1991**

	1987		1991	
	All higher degrees	Research higher degrees	All higher degrees	Research higher degrees
Agriculture	27	23	29	27
Architecture	23	14	23	19
Arts, humanities, social sciences	63	40	63	46
Business administration, economics	27	29	33	28
Education	62	42	67	49
Engineering	6	5	10	9
Medicine, health	63	37	68	41
Law, legal studies	42	22	44	32
Science	32	24	32	30
Veterinary science	33	21	34	35
Total	50	27	52	33

Source: Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1988 and 1992

cent of all engineering degrees completed in 1990 were carried out by overseas students. Engineering was also the greatest growth area for overseas students (from 89 completions in 1987 to 125 in 1990). Overseas completions in arts, agriculture, and health declined over the same period (Table 1.13).

Table 1.13. **Higher education research degrees completed by Australian and overseas students, by field of study, 1987 and 1991**

	1987		1991	
	Australia	Overseas	Australia	Overseas
Agriculture	65	55	90	29
Architecture	18	4	9	7
Arts, humanities, social sciences	287	89	430	74
Business administration, economics	86	15	65	21
Education	85	10	131	21
Engineering	104	89	145	125
Medicine, health	109	38	245	25
Law, legal studies	22	5	20	5
Science	486	132	569	140
Veterinary science	20	14	28	10
Total	1 282	451	1 732	457

Source: Department of Employment, Education and Training, *Selected Higher Education Statistics*, 1988 and 1992

Occupations

According to the most recent census data available in Australia, the majority of persons with higher degrees work as professionals or managers and administrators (90 per cent). The category "professional", however, covers a wide range of occupations. The Graduate Careers Council of Australia has noted that about one-third of new graduates take up teaching posts, about one-third find employment in the private sector, and one-third in government. About one-quarter of Australian and overseas students find employment outside Australia.

In 1988, the Australian government noted its concern about declining career opportunities for outstanding Australian researchers. A conspicuous decline in career opportunities for scientific research in Australia has been a matter of concern for the Australian Research Grants Committee, the CSIRO and the National Health and Medical Research Council for some years. A recent report to the Minister for Employment, Education and Training has identified, as particular cause for concern, "a severe downturn in motivation amongst many of Australia's best young researchers, particularly scientists" (Dawkins, 1989*a*, p. 2).

Opportunities for employment in academic institutions during the 1990s are, however, far from clear. The recent study by Sloan *et al.* (1990) showed pessimism about Australia's ability to produce enough trained academics to fulfil the needs of universities during the next decade. It predicted that the greatest shortfall would be in the physical sciences (Sloan *et al.*, 1990). There is still no clear consensus on this issue, but it is likely that, during the 1990s, opportunities for employment will be unevenly spread across the unified system and across disciplines.

In 1983 the government established a National Research Fellowships Scheme. When the Australian Research Council (ARC) was formed in 1988, it was given responsibility for co-ordinating the research training of postgraduates and the research fellows and "postdocs" employed through such grants programmes. Queen Elizabeth II Fellowships were introduced to promote excellence in research by providing funds for up to 15 outstanding researchers (normally with no more than six years' postdoctoral experience) to work in Australia for up to five years. These Fellows are chosen on the basis of exceptional merit, outstanding promise, and capacity for original work. The fellowship schemes have recently become incorporated into a more coherent structure intended to provide clearer career opportunities for outstanding researchers.

Since 1991, in response to the perceived problems for research careers, a three-tier system of fellowships has been put in place. On introducing the scheme, the Minister noted that the new system would provide new incentives for outstanding researchers and bridge the gap between present limited career opportunities for those wishing to devote themselves to full-time research and the projected significant increase in academic staff positions from the mid-1990s onwards (Dawkins, 1989*b*, p. 3). The current structure can be summarised as follows:

- ARC Postdoctoral Fellow: normally for researchers with less than three years' postdoctoral experience; maximum tenure of three years;

- ARC Fellow: for researchers with at least three years' postdoctoral experience; maximum tenure of five years;
- ARC Senior Fellow: for researchers with no more than 15 years postdoctoral experience; maximum tenure of five years.

A new category introduced in 1991, the Australian Research Fellowships (Industry) is intended to support academic staff in higher education institutions who undertake research and development in an industrial or commercial environment. These awards vary between half-time and full-time appointments. The emphasis is on improving collaboration between industry, commerce, and higher education institutions rather than providing direct career opportunities. These are supported specifically for research in industrial companies and tenure is for a period of three to 12 months.

Between 1989 and 1991, 256 fellowships were awarded, distributed as indicated in Table 1.14. The greatest concentration is in the biological sciences, with over 40 per cent of all fellowships being awarded in sub-categories of this area.

Vocational directions during the 1990s

In Australia, the PhD is generally viewed by employers as a "science" degree. The disciplinary review of engineering, for example, argued the need to reorient the degree towards applications. The HEC Working Party recommended the development of alternative doctoral degrees in order to provide extended and advanced training in certain professional fields.

In 1989 the HEC recommended a general expansion of postgraduate programmes and the introduction of "alternative" doctoral degrees in engineering, accounting, law, education, and nursing. Although these recommendations have not yet been accepted, continued pressures for such changes are likely to remain high throughout the 1990s.

Table 1.14. **Fellowships by field of science**

	1989	1990	1991	Total
Biological sciences (molecular and cell)	14	14	20	48
Biological sciences (plant and animal)	12	15	28	55
Chemical sciences	7	8	7	22
Earth sciences	8	7	16	31
Engineering and applied science	9	12	6	27
Humanities	4	4	9	17
Physical sciences	6	10	23	39
Social sciences	5	5	7	17
Total	65	75	100	256

Source: Australian Research Council, *ARC Awards, 1989-91*

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Conclusions

The higher education system in Australia has undergone significant restructuring. The previous distinction between colleges of advanced education with funding for teaching only and universities with funding for teaching and research was removed during the 1980s. Now all institutions and research staff must compete for research funds. Consequently, postgraduate research training is taking place in a considerably expanded number of institutions and in a more market-oriented environment.

For postgraduate degrees, enrolments in course work degrees have grown at a faster rate than research degrees. Nevertheless, the degree of master's through research and the PhD are still the major forms of research training in most disciplines. These degrees continue to be a training ground for future scientists, with over 30 per cent of all completions in the sciences. The master's degree by course work and other diploma courses continue to cater for more vocationally-oriented postgraduate studies. However, increased student numbers and a greater emphasis on vocational courses at this level are leading to growing demands to extend doctoral programmes into areas specifically related to industry.

Current enrolments among postgraduate research students show a decline in enrolments in the sciences, but lower exit rates are likely to offset proportional redistribution.

At the same time, research in universities is moving away from traditional departmental structures and towards multi-disciplinary problem-oriented and centre-based structures. These are likely to serve as an increasingly important training ground for research students and a source of employment for graduates during the 1990s. As this occurs, there are likely to be further calls for better co-ordination of supervisory practices, supervisory standards, and consistent quality of training. The trend may also contribute to a growing gap between undergraduate teaching and research. A graduate school has already been established at the Australian National University and is likely to be a model with increasing appeal for universities seeking to strengthen their postgraduate training.

Government support for students carrying out postgraduate studies has shifted in intent during the 1980s. The policy move has been away from schemes presented as mechanisms for providing student support towards schemes intended to attract the most promising students to a research career. More and more, research centres within the university system are "topping off" government scholarships in order to attract potential research students.

Finally, the major issues for research training during the 1990s are likely to be developing career paths, building bridges with industry, and attracting the most appropriate students, rather than department numbers and completions. Issues of quality and discussions about institutional and national priorities are likely to take precedence over claims for equitable distribution of resources among disciplines and institutions.

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Chapter 2

RESEARCH TRAINING IN CANADA

by

Gilles Julien

Private Consultant in Science Policy, Ottawa

Introduction

In Canada, 1992 was marked by the debate over reform of the Canadian constitution. This debate monopolised the political agenda at all levels of government. Judging by the high voter turnout at the October 1992 referendum, it also won the attention of the public at large, from the shop floor to the board room, and from students to the professional elite.

The central issue fuelling conflicting claims by public-sector "partners" in Canada was the division of authority, jurisdiction, and spending powers among different government echelons. Education is one area where the division of power appears to be clear-cut, but where responsibility for expenditure is not. Indeed, a report submitted to Parliament by a special committee appointed by the Canadian government and based on an extensive survey of public opinion contained the following statement:

> "We recognize that health, education and social services are under provincial jurisdiction. The federal government has instituted a number of Canada-wide programmes in some of these areas. We believe that the federal government should continue to deliver these." (Beaudoin-Dobbie, 1992, p. 74.)

The Constitution Act of 1867 apparently gave the provincial governments exclusive responsibility for education. However, from the very beginning of the Canadian Confederation, the federal government has provided funding for education, and it has since taken an ever increasing interest in the sector. The most recent document published by the federal government on the subject of education dates from 1985 and makes the following statement:

> "...(there are) about 109 federal programmes, costing an estimated $6 billion [Canadian dollars], aimed at directly or indirectly supporting elementary and secondary school education and education and research in universities and colleges. Post-

secondary education accounts for the largest portion of this." (Task Force on Programme Review, 1985, p. 1.)

In 1991, the federal government spent an estimated C$ 11 billion on education and training. Of this sum, C$ 5.6 billion were transferred to the provinces under Established Programmes Financing (EPF) schemes for post-secondary education, and C$ 710 million were transferred to the universities in the form of direct funding for research administered by three federal research councils.

This brief introduction illustrates both the diversity and the complexity of the division of power between different levels of government with regard to policy towards, and the funding of, training and education in Canada. Even though it might seem that the federal government is primarily responsible for the funding of post-secondary research training, the money spent by the provinces on infrastructure and pre-university training, as well as the role played by the provinces in shaping education policy, cannot but exacerbate the differences that exist throughout Canada with regard to the training of the labour force.

In the following discussion, the term "research training" is used to refer to research activities in which one of the objectives is the training of qualified research personnel; unless otherwise indicated, "research training" covers both the training of researchers and training which uses research as a teaching aid (training through research). In this respect, the situation in Canada differs little from that in other countries: research training is more or less the exclusive preserve of the universities. Although some undergraduate courses may occasionally include a research component, research training is primarily reserved for postgraduate students, *i.e.* those undertaking master's and doctoral degree programmes, as well as postdoctoral research. The main focus will be on training in the natural sciences and engineering.

Structure of university degrees in Canada

Canada has 60 universities, *i.e.* post-secondary educational establishments authorised to award degrees. Some only offer the first degree level (bachelor's degrees), whereas others are authorised by their respective provincial governments to grant master's and/or doctoral degrees. In the natural sciences and engineering, 26 universities offer master's and doctoral degree programmes; a further 12 universities offer programmes only up to the master's level. The Canadian university system is therefore very diverse, a direct consequence of the regional and provincial differences mentioned above. In view of the potentially adverse impact such diversity might have on the educational system, the universities have formed themselves into an association: the Association of Universities and Colleges of Canada (AUCC). One of the aims of the AUCC is to standardise, to the greatest extent possible, the teaching and training programmes offered by universities throughout Canada (or rather across provincial borders), with the result that graduates of one university are now eligible for postgraduate study at any other university (in any other province) in Canada. It would therefore be fair to say that, despite

minor differences in the composition of individual courses, the quality of teaching does not vary enormously from one university to another.

Undergraduate studies

It follows from the above that research activities also differ from one group of universities to another. While it might be argued that the 26 universities offering master's and doctoral programmes necessarily have fuller research programmes and a greater critical mass of researchers than smaller universities offering courses solely up to the bachelor's degree level, it should be noted that professors in the smaller universities also carry out research; indeed, they are actively encouraged to do so by their universities and commonly allow undergraduate students to participate in their research projects. In fact, it is not uncommon for graduates from the smaller universities to score some of the highest marks in national competitions for postgraduate fellowships, which would indicate that their exposure to research provides them with a solid grounding for research training at a higher level.

Master's and doctoral studies

Postgraduate education in science and engineering in Canada has two distinct objectives. The first is to provide higher degree courses, with the emphasis on research-oriented training, in order to prepare students for degrees leading to a career in university teaching or research. The second is to provide courses of advanced study, which usually do not include research work, for students intending to pursue careers outside the research sector in the private or public sectors. Two degree programmes are offered at this level: master's programmes and doctoral programmes. The normal route is for students to study for a master's degree before enrolling in a doctoral research programme. In many cases, a master's degree is the highest qualification obtained, and in practice only a small number of master's degree graduates go on to study at doctoral level.

Master's degrees

There are two types of master's degree: one based on research, and one, referred to a vocational or professional degree, which does not usually include a research component. The nature and role of research degrees at the master's level will be discussed below. The unusually lengthy programme for master's degrees is perhaps a result of the way in which the university research system has evolved in Canada. The time taken by a full-time student to complete a master's degree programme can vary from as little as nine months (although this is rare) to over two and in some cases even four years. A few master's degree programmes in the sciences, and particularly in engineering, do not include any research-oriented training. In programmes such as these, students are required to attend courses and occasionally to carry out a project. These degrees can be obtained within a relatively short period – usually no more than 18 months of full-time study. However, most master's degrees in the natural sciences and engineering include a substantial

research component. In addition to a programme of coursework, students enrolled for master's degrees of this kind are required to carry out a research project and to submit a thesis. The research component may require over a year of full-time work. As a result, a master's degree in research usually requires over 18 months of full-time study.

Doctoral degrees

In Canada, for a number of years now, doctoral programmes have been the mainstay of research training. As mentioned above, applicants to a doctoral programme must normally have already obtained a master's degree. However, there are other options. In certain subjects at some universities, graduates can enrol directly for doctoral programmes after their first degree, as in the United Kingdom. Such cases are rare, however. Increasingly, the normal route is for students to transfer from a master's to a doctoral programme at the end of, say, the first year of the master's course; in such cases, the students will not complete the master's programme. Given that this option allows students to reduce the total time required to obtain a doctorate, it is seen as a logical way in which to avoid spending too much time on the master's degree. This option thus allows the more able students, who do not require a master's as their final degree, to take a short cut to a doctorate.

Postdoctoral research

In Canada, as in other countries, research training sometimes continues beyond the doctorate level. In the sciences, in particular, the usual practice is to "finish off" research training with postdoctoral research, often in a laboratory abroad. The postdoctoral training period is also important, indeed essential, for students intending to pursue academic careers. In engineering, even at university level, doctoral students are less likely to do postdoctoral research. The reason is pressure from the labour market (particularly from industry), as well as traditions in Canadian universities. Even though industry now places an increasingly high premium on doctoral students, it encourages them to complete their training in-house rather than through "irrelevant" postdoctoral work. In many universities, the recruitment of engineering professors at doctoral level is a relatively recent phenomenon; it should come as no surprise, therefore, that doctoral students in engineering show little interest in undertaking postdoctoral research.

However, in both the natural sciences and engineering, there can be no doubt that periods of postdoctoral research are designed to train researchers and not to train through research. It is at the postdoctoral level that young researchers hone their investigative skills, discover and analyse new ideas, explore new and promising avenues of research opened up by their doctoral studies, and work alongside renowned researchers.

Current status of research training

The following is an analysis of statistics relating to the number of degrees awarded and the research training resources available at national level. The most recent set of complete data are for 1990. Table 2.1 summarises the total number of degrees awarded by Canadian universities in 1980 and 1990. Table 2.2 provides a breakdown of master's and doctoral degrees awarded in 1990. These tables show that in 1990:

– 20 per cent of all degrees awarded were in the natural sciences or engineering;

Table 2.1 **Degrees awarded by Canadian universities, 1980 and 1990**
Including bachelor's, master's and doctoral degrees

	Percentage	
	1980	1990
Social sciences	32	38
Health	6	7
Agricultural and biological sciences	6	6
Mathematics and physical sciences	5	6
Engineering and applied sciences	9	8
Other subjects	42	35
Total[1] (number in 1980: 100 580) (number in 1990: 130 104)	100	100

1. Full-time enrolment at universities in 1990/91: 532 000.
Source: Author.

Table 2.2 **Degrees awarded in 1990**

	Natural sciences and engineering		Other subjects		Total	
	Number	%	Number	%	Number	%
Doctorates	1 236	4.75	1 450	1.4	2 686	2.1
Share of total doctorates	46%		54%		100%	
Master's degrees	3 644	14.0	13 708	13.2	17 352	13.3
Share of total master's degrees	21%		79%		100%	
Other	21 140	80.25	88 926	85.4	110 066	84.6
Share of total other degrees	19.3%		80.7%		100%	
Total	26 020	100	104 084	100	130 104	100

Source: Author.

- 4.75 per cent of all degrees awarded in the natural sciences and engineering were doctorates, compared with merely 1.4 per cent in other disciplines;
- 25.3 per cent of all postgraduate degrees awarded in the natural sciences and engineering were doctoral degrees, compared with merely 9.5 per cent in other disciplines;
- the natural sciences and engineering accounted for 46 per cent of doctorates and 21 per cent of master's degrees awarded in 1990.

A comparison of Tables 2.1 and 2.3 makes it possible to analyse historical trends in the number of degrees awarded. The first point to emerge from the comparison is the significant percentage increase in the number of degrees awarded in the social sciences (which rose from 32 per cent in 1980 to 38 per cent in 1990); the second is the fact that the number of degrees awarded in the natural sciences and engineering has remained constant. However, Table 2.3 reveals that the sharpest increase was at the doctoral level: the number of doctoral degrees awarded between 1980 and 1990 rose by 68 per cent, compared with an increase of only 29.3 per cent in the total number of degrees awarded. Since research training is primarily available at the doctoral level and in universities, these data would seem to indicate that the overall situation in the natural sciences and engineering is relatively healthy, even though the statistics in Table 2.3 also include foreign students enrolled in master's or doctoral programmes.

Closer analysis of these data provides a clearer picture of the situation in Canada, which can then be examined in terms of supply and demand for qualified personnel (see below). Table 2.4 compares increases in the number of doctorates awarded between 1980 and 1990 in the areas of: agricultural and biological sciences (ABS); engineering and applied sciences (EAS); and mathematics and physical sciences (MPS). Medical sciences, management sciences and psychology have not been included. In addition, although 90 per cent of the EAS group are engineering students, this group also includes forestry science and architecture. Computing sciences are included in the MPS group. The greatest growth is therefore in engineering and applied sciences (up 116 per cent between 1980 and 1990); in comparison, growth in mathematics and the physical sciences would seem to have slowed, with the share of doctorates awarded falling from 45 per cent to 39 per cent over the decade.

Table 2.3. **Change in the number of degrees awarded in the natural sciences and engineering between 1980 and 1990**

	1980	1990	Change (%)
Doctorates	735	1 236	+68
Master's degrees	2 493	3 644	+46
Other	16 888	21 140	+43
Total	20 116	26 020	+29.3

Source: Author

Since the size of the pool from which graduate students will be drawn is heavily dependent on the number of students enrolled in undergraduate courses (more so in Canada than in other countries), and given that those students who will be receiving doctorates in five to seven years' time are at present enrolled in lower degree courses, it is possible to gain some idea of the situation by examining current trends in enrolments and degrees awarded in the areas described above. To ensure a valid comparison, the data given in Table 2.5 relate solely to students of Canadian origin or with permanent resident status; they therefore exclude foreign students, who usually obtain their first degree in their home country. The educational system is rather like a pipeline – leaks and all. A certain percentage of students with bachelor's degrees will subsequently enrol in master's and doctoral programmes, and a certain percentage of master's students will subsequently go on to study for doctorates. In consequence, a trend at one level will affect trends at higher levels.

Table 2.4. **Doctorates awarded by Canadian universities in the natural sciences and engineering**

	ABS	EAS	MPS	Total
1980	210	191	334	735
1985	248	278	386	912
1990	338	413	485	1 236

ABS Agricultural and biological sciences
EAS Engineering and applied sciences
MPS Mathematics and physical sciences
Source: Author.

Table 2.5. **Trends in enrolments and degrees**
(Canadians and permanent residents)

	Bachelor's level		Master's level		Doctorate	
ABS	ENR	→	ENR	↓	ENR	↑
	DEG	→	DEG	↓	DEG	→
EAS	ENR	↑	ENR	↑	ENR	↑
	DEG	↓	DEG	↓	DEG	↑
MPS	ENR	→	ENR	↓	ENR	↑
	DEG	↓	DEG	↓	DEG	→

ABS Agricultural and biological sciences
EAS Engineering and applied sciences
MPS Mathematics and physical sciences
ENR Enrolments
DEG Degrees awarded
Source: Author.

Table 2.5 would seem to indicate that the situation in the EAS group is relatively healthy: enrolments are rising at all levels, and the prospects for growth in the number of degrees awarded at all levels would seem to be reasonably promising. It needs to be borne in mind, however, that the number of students enrolling in engineering courses is heavily influenced by the state of the Canadian economy. As a result, forecasts regarding future numbers of engineering graduates tend to be somewhat volatile. The situation in the ABS group is comparable to that in the MPS group. In both, student enrolments are stable at the undergraduate level, declining at the master's level, and increasing at the doctoral level. The number of Canadians and permanent residents obtaining degrees in these fields, at all levels, is either stable or declining. The long-term outlook in terms of future graduates at the master's and doctoral levels is therefore none too rosy, given the "pipeline" effect mentioned above.

Structure and current organisation of research training

Research-oriented training in Canada cannot be said to be a formally organised activity. Although it is widely recognised that it is the role of the universities to provide training in research, university professors and administrators tend to treat teaching and research as separate areas of activity. They are often encouraged in this way of thinking by the mechanisms for, and policies towards, research funding. Research supervisors and university administrators are, to all intents and purposes, employees whose salaries are paid by the provincial authorities. The provincial governments, however, are responsible for framing policy on, and providing funding for, teaching activities. Research activities, in contrast, are mainly paid for, and administered by, the federal government.

This situation, which is ambiguous to say the least, and which was described above, has had an influence on commentators, associations, and organisations concerned with research and teaching in Canada. Recent publications bear witness to their interest and concern. For example, in February 1991 the Royal Society of Canada published a report entitled *Realizing the Potential: A Strategy for University Research in Canada*. Even though this report stresses, on several occasions, the close links between university research and the training of qualified personnel, most of the changes it advocates are directed "towards the creation and enhancement of the kind of national research structure that is essential to social, cultural, and economic development" (p. 36). The report was primarily aimed at allowing university researchers "to make an existing contribution, along with their colleagues in other advanced nations, to the increase of the world's knowledge and understanding" (p. 35).

In view of its message, it is not surprising that this report was followed by another, commissioned this time by the Association of Universities and Colleges of Canada (AUCC, 1991), which focused on education in the universities. The author prefaced this report (p. 7) with the following comment: "The terms of reference were to report on how well the universities were carrying out their educational mandate and to make recommendations for the future. (The research mandate of the universities was studied in detail by the Royal Society of Canada, which submitted a report on this subject in February 1991)."

The lack of any formal government policy towards research training has not prevented the Canadian university system from developing harmoniously. As stated earlier, graduates of any university, from any province of Canada, are generally eligible to enrol directly in higher degree courses at any other university in Canada. In principle, therefore, the most qualified graduates from Canadian universities are perfectly capable of undertaking master's and doctoral degree programmes, as well as research-oriented training.

Undergraduate students are not usually exposed to research activities. Over the past few years, however, the universities, with encouragement from the federal granting councils, have been offering undergraduate students the opportunity to enrol in practical courses in research laboratories. Each year, for example, the Natural Sciences and Engineering Research Council (NSERC) allocates a number of awards to the universities to allow them to sponsor students wishing to undertake such courses. These awards are valid for four months and are generally given for the summer term. A NSERC survey of students who had benefited from awards revealed that the scheme had attracted students into the research sector who otherwise would not have contemplated embarking on a career in science.

Research degrees at master's level

First-degree graduates can, in principle, pursue their studies at a higher level by enrolling in either a master's or a doctoral programme. The master's degree in research serves two purposes. It is often used by students, primarily in engineering, as a final degree prior to a career in research. Industrialists generally consider that the research training component of a master's degree in engineering provides graduates with the essential methodological skills required for a career in a research laboratory. A research master's degree can also be used as a springboard to a doctorate. In most cases, students complete the master's degree before commencing a doctoral programme; indeed, it is not uncommon for students to pursue their doctoral studies at another university or under a different research supervisor. In some cases, however, students may move on directly from a master's to a doctoral programme without changing their research topic, with the result that some master's theses are virtually indistinguishable from a doctoral thesis. This is a major cause of concern for the deans of graduate schools, who are stepping up their efforts to make master's programmes more realistic.

Doctorate

The requirements for doctoral programmes vary from one university to another and according to the field of study. Nonetheless, all doctoral study programmes require applicants to complete a substantial programme of research which is normally expected to achieve a significant advance in knowledge of a given area. As a rule, the results of such research must be published, either in whole or in part, in a scholarly or scientific journal. For engineering students, other methods of disseminating research results are also accepted and indeed encouraged. Doctoral theses must also be defended orally before an

Examination Committee made up of experts from the candidate's university and an external examiner from another Canadian or a foreign university. Candidates for doctoral degrees are also required, in most cases, to follow advanced courses in their subject area or a related field. In the engineering sciences, research training usually ends at the doctoral level. In the natural sciences, training may be continued in the form of postdoctoral studies, especially for candidates who intend to pursue academic careers. Most postdoctoral researchers continue their studies and research work abroad.

In most cases, pre-doctoral or postdoctoral training is provided by the universities. This does not prevent researchers working in other sectors from participating in the training of students, however. In some fields, for example, researchers from government laboratories may be given posts as adjunct professors, thus allowing them to supervise courses of advanced study.

With regard to industry, several Canadian universities have introduced collaborative teaching programmes. Although most of these programmes are at the undergraduate level, it is becoming increasingly common for master's and doctoral scholarships to be awarded to researchers spending part of their time working in industry. However, it is mainly at the postdoctoral level that industry provides more in the way of research training. A number of these partnerships with industry are discussed below.

Funding for research training is supplied from a variety of sources. Graduate scholarships remain the commonest and, at the same time, the most direct form of funding. They are granted on the basis of competition. Several provincial agencies award graduate scholarships. The *Fonds pour la formation de chercheurs et l'aide à la recherche* (FCAR, Fund for the Training of Researchers and Aid to Research) in Quebec is the most well-known of these agencies. There are also a number of graduate scholarship programmes in Ontario and British Columbia. However, the main source of funding for graduate studies remains the federal government, which awards grants through three research councils (the Medical Research Council, the Social Sciences and Humanities Research Council, and the Natural Sciences and Engineering Research Council).

These three Councils offer awards for both undergraduate and graduate degree programmes, although it is the NSERC which awards the largest number of postgraduate scholarships. As a general rule, postgraduate awards may be held at any Canadian university. A small number of scholarships are awarded to students enrolled at foreign universities. Postdoctoral scholarships may be held at the Canadian or foreign institution of the student's choice. All scholarships are awarded on the basis of nation-wide competitions, and successful applicants are chosen by means of selection committees made up of national and international experts.

Although provincial or federal student awards suffice to meet living expenses, they are not competitive with the salaries offered to recent graduates – particularly graduates in engineering or computer science. To compensate for this, the universities offer supplementary awards to students in return for light teaching duties.

Research subsidies are another source of funding for training in research. In the natural sciences and engineering, over 20 per cent of the funding allocated to university researchers in the form of grants for research projects is used to pay pre-doctoral or postdoctoral students what amounts to a kind of salary. Indeed, it is now NSERC policy

to support research projects that contain a significant training component. This policy has not escaped comment or indeed criticism, even on the part of the universities. In order to allay its more vociferous detractors, the NSERC has introduced the concept of training through research, an idea borrowed from the French research system. It is now standard practice for NSERC research grants to be used to train not only researchers, but also professional research workers, technicians, or other research personnel by using research as a teaching aid.

Regardless of whether they receive their awards directly or in the form of a salary paid out of a research grant, pre-doctoral and postdoctoral students are not considered employees of the institutions in which they undertake their training, nor of the granting councils. They therefore have the status of students, except in the case of temporary employment on a specific project for which a contractual wage is justified.

Canada has no research schools of the type found, for example, in the Netherlands. However, there is one university institute in Canada offering advanced degrees at master's and doctoral level only: the *Institut national de recherche scientifique* (INRS, National Institute for Scientific Research). The INRS is one of the constituent institutions making up the network of universities known as the *Université du Québec*. Originally intended to be the equivalent of the faculty of advanced studies within the *Université du Québec*, the INRS is now a full constituent part of the university, with its own specific research programmes, administrative council, and scientific commission. The INRS is therefore an institution wholly committed to training for and through research. Students who enrol at the INRS are graduates not only of other constituent institutions of the *Université du Québec*, but also of other universities in both Quebec and the other provinces of Canada.

Training and the labour market

Ideally, the labour market should serve as a backdrop to training. This is true not only for training in research, but also for vocational or general training. Approaches to training vary substantially, however, depending on the level of educational achievement. It is for this reason that general training provides an easier, and above all swifter, response to the needs of the labour market. With training in research, however, the time required to provide an adequate response to the specific needs of the labour market is far too long for an effective link to be established, with any degree of confidence, between supply and demand. The only resort, therefore, is not only to make do with trend analysis, but also to find some means of managing these trends through collaboration, co-operation, partnerships, etc.

Several studies recently published in Canada have stressed the growing need in all S&T sectors for PhD graduates in science and engineering. The Conference Board of Canada, for example, predicts that there will soon be shortages of research personnel in the areas of engineering, computer science (software specialists), chemistry, and the environment. At the same time, demographic studies of the rising average age of university and government research staff have drawn attention to the growing need for research-

ers in those very fields of study. All of these studies are hoping to communicate this information not only to those formulating policy on training and funding, but also, and above all, to high-school students about to enter universities and who have not yet decided on a career.

However, despite the relatively clear picture painted by these trends, policy-makers are currently under the sway of other forces urging them to err on the side of caution. Decision-makers in the universities and government are reluctant to change either their policies or their funding schemes. The fierce demand for biotechnologists which has emerged throughout industry over the last ten years, for example, did not appear as a trend 17 or 20 years ago. Industry, for its part, is willing be influenced by certain trends, which it also helps to document, but the current economic climate prevents it from sending the right signals with regard to its real requirements. Although industry, prompted by the recession, is willing to recruit researchers in areas of high demand (provided that there are any researchers to be recruited), it is only on the condition that government offers it subsidies to do so. The net result is that industry is recruiting fewer young first-degree graduates in these areas (particularly engineering), and thus sending the wrong signals to students. Even though the number of students enrolling in engineering courses is increasing in absolute terms, the rate at which numbers are rising is lower than in other disciplines, and the relative proportion of these enrolments is therefore starting to show signs of declining.

Nonetheless, the employment record of recent university graduates gives some grounds for hope of an improvement. Table 2.6 shows that 68 per cent of all engineering and applied science graduates in 1986 found work in their field of study and were still working in the same sector two years after graduating. The same was true of mathematics

Table 2.6. **Employment of 1986 science and engineering graduates two years after graduation**

Percentage

	Agricultural and biological sciences	Engineering and applied sciences	Health	Mathematics and physical sciences	Social sciences	All graduates
Managerial and administrative	13	13	6	13	19	21
Natural sciences, engineering and mathematics	15	68	1	53	4	13
Social sciences	3	–	3	–	28	9
Teaching	18	4	6	16	14	24
Medicine and health	18	–	80	–	3	10
Clerical	8	1	1	5	14	9
Sales/services	13	3	1	4	11	8
Other occupations	12	11	2	9	7	6

Source: Statistics Canada

and physical science graduates, who scored a comparable figure of 53 per cent, but not of graduates in the social sciences, and even the biological sciences, who found employment in a wide variety of areas. These signs should therefore encourage students to enrol in subjects which would seem to offer most job stability.

Current concerns regarding research training

In Canada, the main concerns with regard to research training are basically the same as those of other industrialised countries and include the following well-known themes:

- *Growing need for qualified personnel:* The Canadian economy has for many years been based on the exploitation of Canada's natural resources; following the example of several other industrialised countries, Canada must increasingly invest in the development of its human resources to ensure its technological competitiveness.
- *Difficulty of attracting enough students to advanced degree courses in certain subjects:* Despite the growing demand for qualified personnel in frontier disciplines, there is a mismatch between supply and demand for research personnel and there is considerable difficulty in matching the labour supply to the real needs of the market.
- *Nature of advanced studies:* Students enrolling in advanced degree programmes frequently choose areas in which supply outstrips demand. They take too long to complete master's and doctoral degrees, and their training is not sufficiently interdisciplinary.
- *Quality of students:* Many undergraduate students entering university have an inadequate preparation in science and mathematics. This situation improves by the time students obtain their first degree, but the lack of pre-university preparation limits the potential pool of graduate students capable of pursuing graduate courses in science and engineering.
- *Women in science and engineering:* In Canada, as in other countries, the number of women enrolling in science and engineering courses is relatively small; those who do enrol, however, are of very high quality and appear to be more motivated than men.

Recent studies in this area, as mentioned earlier, focus more on the teaching and research system than on training in research *per se*. In a recent report on education and vocational training in Canada, the Economic Council drew attention to a number of weaknesses that might, in the long term, have an adverse impact on training in research (1992, p. 41):

> "One major concern about the Canadian educational system is that close to one-third of students fail to complete their secondary schooling. A large proportion of secondary school graduates do go to university, but many of them then drop out before completing their studies at that level."

"Moreover, the scientific fields of study deemed essential to a country's future attract a smaller proportion of students in Canada than in many other countries. While this is especially evident among female students, male enrolments are also relatively low. The relatively low enrolments in scientific disciplines may reflect – and at the same time, reinforce – Canada's low commitment of resources to research and development."

Faced with relatively scarce resources, university researchers are turning increasingly towards contract research, which is a far less satisfactory way of training researchers. This trend also has an impact on their long-term research programmes. This is a cause of growing concern in a number of countries and is even starting to worry the private sector. In a report setting out its recommendations on strategies towards university research, the Royal Society of Canada emphasised (1991, p. 12) that:

"While the committee's private sector respondents were by and large supportive of the various collaborative and matching initiatives that have from time to time been put in place, they often expressed the view that the universities could best help industry by conducting high-quality basic research and producing well-trained graduates capable of acquiring applied skills at a later stage."

New initiatives

In order to encourage more university professors/researchers to play an active role in research training, the granting agencies for research have launched a series of new initiatives, of which the most important are outlined below.

As mentioned above, NSERC has decided to reinforce the concept of research training by making it one of the selection criteria for all the research grants it awards. Researchers applying for grants must now specify the contribution that their research projects will make to training. Those who decide not to include a training component in their projects must provide a satisfactory explanation of why this is so, failing which the grant will be withheld. Respect of this criterion is assessed by peer-review committees which subsequently recommend whether or not a grant should be awarded.

Since 1988, under its **Canada Scholarships Programme**, the federal government has awarded at least 2 500 scholarships a year to the best undergraduate students, both male and female, in the natural sciences and engineering. This programme is designed to increase the number of students enrolling in undergraduate courses in the natural sciences and engineering, and to encourage more women, who are at present under-represented, to enrol in these areas. Over the 1991/92 academic year, 12 763 applications were received for Canada Scholarships, an increase of 32 per cent over the previous year; in response to this demand, the number of scholarships offered rose to 3 194, of which 52 per cent were awarded to women. This programme has been adopted by virtually all the universities in Canada, which see it as a means of creating a pool of future candidates for training in research.

The government launched its **Networks of Centres of Excellence** programme in 1988. It received 158 proposals and set up 15 networks. These networks constitute an

innovative approach to R&D. Each network is a unique entity linking the best research teams at university, industry, and government levels in a given area of strategic importance to Canada. These networks allow individual partners to enter into contact with each other and are thus helping to train the next generation of Canadian researchers: over 950 graduate students and 390 postdoctoral students receive special training within teams enjoying strong support from industry.

Following the announcement of its Green Plan in 1990, the Federal Government asked the three granting councils to launch and manage a special programme known as the **Eco-research Programme**, aimed primarily at promoting research and training related to environmental issues. The programme is administered by the Humanities Research Council on behalf of the three councils. In addition to promoting research training through the award of research grants, the programme includes a special measure aimed specifically at doctoral students. The results of the first competition for doctoral scholarships were announced in 1992; in all, 31 scholarships were awarded, 17 of which were in fields relating to the natural sciences and engineering. It is still too soon to assess the impact of this programme, although the fact that it gives priority to interdisciplinary training illustrates the special requirements applicable to environmental issues.

A programme of **undergraduate student research scholarships**, which was set up by NSERC, offers financial support to undergraduate students in the natural sciences and engineering who wish to spend the summer, or a period of work placement, in a research laboratory. The aim of this programme is to give students an opportunity to acquire experience in research work and also to encourage students to undertake postgraduate training. Each year, some 2 500 scholarships are awarded to students working in university laboratories, and a further 550 scholarships are offered to students working in industrial laboratories.

Since it was first introduced by NSERC in 1980, the **Industrial Research Fellowships Programme** has helped to place almost 500 recently-qualified doctoral students in the industrial R&D sector. For a period of two years, NSERC pays the employer part of the researcher's salary. Applications for such fellowships are submitted by individual companies and examined by a selection committee. The main criteria for the granting of awards are the excellence of the candidate and the relevance of the research project proposed by the company. At present, NSERC is able to offer 78 new fellowships a year, and to date over 200 firms of all sizes have benefited from this programme. It is interesting to note that 27 per cent of such grants were awarded to companies with a staff of 50 or fewer employees, and that 51 per cent of the grants were awarded to SMEs (*i.e.* firms with fewer than 200 employees). Over 60 per cent of the fellows have since accepted permanent posts with their host company, and 15 per cent are now working for other companies. The programme allows companies to assess potential long-term employees before offering them a full-time post. For postdoctoral fellows, these awards allow them to complete their training in research and to gain an idea of the possibilities open to them in the industrial R&D sector.

A new NSERC **Woman Faculty Awards Programme** is aimed at improving the chances of university careers for a small number of young female researchers who already hold a doctorate in the natural sciences or engineering. These fellowships are

tenable for a period of five years, during which candidates are expected to devote most of their time to research; to do this, they receive a research grant which also allows them to take part in training in research programmes.

A **Research Reorientation Fellowships Programme**, which was launched in 1992 by NSERC, is designed to help students with doctorates in the natural sciences and engineering, who have interrupted their research career due to family commitments for a period of at least five years, to complete their training in research through postdoctoral placement under the supervision of a researcher already receiving NSERC funding.

Conclusions

In Canada, as in all countries around the world, the traditional training format, in which training and work are treated as distinct stages in a person's career, is increasingly being replaced by the concept of ongoing training, a continuous process in which primary and secondary schooling prepare individuals for higher and vocational training, and ultimately for the labour market. Training is therefore completed by work, and through work individuals complete their training. From its position ten years ago as a purely academic discipline, research, particularly in universities, is increasingly being viewed as both a creative activity and an instrument for training. Since work and training are part of the same ongoing process, it should come as no surprise that work experience provides the backdrop for training. In Canada, the "marriage" of work and training is not as easy to achieve in scientific and technological fields as it is in more traditional areas: the poor research performance of the private sector, the main employer, has obliged it to seek closer ties with the universities than it generally has in other countries. It is a fact that private sector funding of university research is relatively higher in Canada than in other countries in the OECD area. This might perhaps explain the success of the collaborative training programmes developed by some Canadian universities, in which students undertake periods of training in industry in the form of work, and sometimes research.

While circumstances have prompted the private and academic sectors to co-operate to improve the continuity of general training and training in research, the same cannot be said of the intrinsic and essential continuity of the training process itself: the continuity between high-school or pre-university training and the training provided by the universities. Co-ordination between these two stages in the training process is not always, and in some cases clearly is not, very smooth, as a result of the different measures introduced by the two levels of government involved. Pre-university training, which is under the exclusive jurisdiction of the provinces, does not necessarily provide the requisite grounding for training in research, which is mainly funded by the federal government. Some provinces have already launched training programmes, even at undergraduate level, in areas other than those funded by the federal government and according to different criteria. Paradoxically, by virtue of the massive transfer of funds from the federal government to provincial governments for post-secondary education, the federal government could have a greater say in the formulation of policy on training in research; the reason that it does not is that this would raise politically-sensitive constitutional problems. As the need for qualified research personnel becomes more acute, and the

requirements of the labour market more clear-cut, the two levels of government will have to draw up strict lines of demarcation with regard to the sharing of responsibilities and the co-ordination of policies and programmes. The time when such co-ordination will be a necessity is fast approaching.

Training in research is not an activity with which Canadian taxpayers are particularly familiar. The work of the universities is generally held in esteem by the general public; many Canadians have already benefited, or hope to benefit, from a university education. However, the close link that exists between research and training is by no means self-evident, even to a university graduate. Research, and particularly research-oriented training, is a secondary, or even a tertiary, consideration when assessing the value of a university. To take an example, a recent, and highly acclaimed, survey by the Canadian magazine *Maclean's* (1992) ranked Canadian universities according to several criteria: 20 per cent of the final score for each university was awarded for the quality of the teaching faculty, including the number of professors with doctoral degrees, success in securing grants, citations and honours gained, etc. Other criteria included the size and quality of classes (18 per cent), the quality and origin of the student body (20 per cent), university finances (10 per cent), library resources (12 per cent), and reputation within the community at large (20 per cent).

Research training is therefore an important activity for those who practice it, participate in it, and consider that it plays an essential role in the development of competitive skills in science and technology. It is of negligible importance, or nearly so, to those who take a broad view of the role of universities, or who place the universities in their macroeconomic or macrosocial context. It is practically unknown to the vast majority of the population. Without wishing to make research training the single most important and necessary component of the continuing link between training and work, "trainers", who are also researchers, would be well advised to raise public awareness of the nature of their activity and the potential spin-offs that it offers. They would undoubtedly be the first to reap the rewards of such an approach.

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Chapter 3

RESEARCH TRAINING IN FINLAND

by

Ulla Ekberg

The Academy of Finland

Introduction

In 1991, Finland allocated approximately Mk 10 billion, or 1.91 per cent of GNP, to R&D activities. The private sector, primarily industry, accounted for 62 per cent, and institutions of higher education and other public sector performers accounted for 19 per cent each. In the 1980s, research allocations rose annually by an average of 10 per cent, one of the highest increases in the OECD countries.

The Finnish higher education system

In 1992, there were 20 institutions of higher education in Finland, of which ten multi-faculty universities, one college of veterinary medicine, three universities of technology, three schools of economics and business administration, and three institutions for the arts (theatre, music, and industrial arts). Two of the institutions of higher education use Swedish for teaching.

Institutions of higher education offer degree programmes in various fields. They also undertake scientific research and assure postgraduate education. During the last few years, they have provided increasing opportunities for continuing education and open university instruction. In 1992, their expenditures totalled Mk 1 544 billion.

In 1991, 115 600 students were enrolled in institutions of higher education, including 17 100 new students accepted in that year. The aim is for about one-quarter of the age cohort to obtain training in institutions of higher education. Teaching staff numbered 7 800 and other staff 13 600.

Finnish higher education is regulated by legislation, and the present Higher Education Development Act, which names the institutions of higher education, took force in 1986. The act also stipulates that appropriations for the institutions of higher education

should increase annually by an amount at least equal to the increase in costs. Under the act, the Council of State is to approve a five-year higher education development plan every four years. In 1991, the Council of State approved a development plan for the years 1991-96.

In connection with the act, the Council of State took a decision of principle concerning the development of institutions of higher education in 1988-91. The decision included an annual increase of 15 per cent in appropriations (excluding salaries of permanent teaching staff and construction costs) for institutions of higher education. At the same time, the Council of State intended that the new resources should be allocated primarily to improve the basis of research and researcher training, to enhance activities, and to gain better results.

Development of researcher training as part of science policy

Researcher training constitutes an important part of all Finnish science policy planning of the last ten to 15 years. Plans for researcher training have been drawn up by various committees and working groups (in 1975, 1981, 1983, and 1989). The latest, the Postgraduate Education Committee of 1989, was chaired by Chancellor Olli Lehto, and its report will be described below. In-house studies and plans for various fields of science and individual disciplines have sought to promote researcher training.

Several groups have worked to develop basic research. In 1980, 1984, and 1989, three working groups investigated the state, resources, and future prospects of basic research in Finland. The central funder of basic research, the Academy of Finland, also draws up plans for its activities, the latest of which dates from 1993. In all these documents, the structure, forms, funding, and duration of researcher training are widely discussed.

The Science and Technology Policy Council is the highest science and technology policy body in Finland. It is chaired by the Prime Minister and has a membership consisting of several ministers and science and technology policy representatives and the employers' and employees' organisations. The Council draws up a three-year science and technology policy review; the latest dates from 1990. The reviews also deal with researcher training, usually on the basis of the latest committee reports, and recommendations for further development are given.

Researcher training is naturally an essential part of all reviews, plans, and recommendations regarding institutions of higher education, and these will be discussed below. Studies on researcher training have been carried out at the Academy of Finland, in particular by Teuvo Räty, who is in charge of planning; these have been used in this report. They have dealt with the number of PhDs, the duration of researcher training, the age structure of PhDs, women's share in researcher training, as well as changes that have taken place in the defence of doctoral dissertations.

Researcher training in the light of international evaluations

The Science and Technology Policy Council has assigned to the Academy of Finland the task of performing evaluations of various disciplines with the aid of international experts. A first evaluation, on research in inorganic chemistry, was completed in 1983. Up to the end of 1992, twelve evaluations had been carried out. All these evaluations have expressed criticism of researcher training in Finland.

The Ministry of Education has undertaken two evaluations of the degree system in the natural sciences and the humanities, in the course of which researcher training is also discussed. The activities of the Academy of Finland, the University of Jyväskylä, and the University of Oulu are being evaluated by international experts assigned by the Ministry of Education. These evaluations have not yet been completed.

Criticism of researcher training has also been expressed in the evaluation reports, but very little progress has been made. The following are central problems, although not all are relevant to all the fields evaluated:

- small university institutions which do not offer enough researcher training and possibilities for postgraduate study (posts);
- too few international contacts;
- too few researchers seeking training abroad;
- excessive length of researcher training;
- age of doctorate recipients;
- uncertain entry into a research career;
- lack of university posts (between researcher training posts and professorships) for PhDs;
- too much publishing in Finnish and in Finnish scientific journals;
- too little inter-university mobility among researchers.

As will be seen below, these problems have received close attention. Various plans have also been drawn up to improve the situation, especially by the Academy of Finland, and many development measures have been already taken.

Postgraduate Training Committee chaired by Chancellor Lehto

The latest development plan for researcher training was prepared, on the initiative of the Ministry of Education, by a committee chaired by Academician Olli Lehto, Chancellor of the University of Helsinki (Ministry of Education, 1990). The committee worked for a year and a half and was assigned the task of drawing up researcher training programmes in co-operation with the institutions of higher education.

The committee arranged a large seminar on researcher training, for which two separate reports were prepared: an estimate of researcher training needs by 2000 (Pimiä, 1989); and a report on the funding of postgraduate studies for those who earned their doctorates (PhDs) in Finnish higher education institutions in 1988 (Halinen, 1989). These reports were an important source for the present study.

The committee recommended that the institutions of higher education should form joint researcher training programmes in order to support and enrich researcher training in various faculties and departments of institutions of higher education. The most important tasks of the researcher training programmes are to arrange high-quality courses and seminars and to disseminate information regarding researcher training.

The committee advocated promoting researcher training as an entity with the following important parts:

- improving university teachers' qualifications for providing researcher training;
- offering material and intellectual support to postgraduate students;
- forming and supporting active research communities and promoting scientific debate;
- furthering international scientific contacts and linkages to researcher training;
- increasing the prestige of researcher training outside institutions of higher education.

The committee expressed the view that researcher training should be arranged so that it leads directly to a doctorate, with the "licentiate" degree (similar to a master's degree) as an optional intermediate stage. The aim is for PhDs to be obtained in four years of full-time study.

The committee report includes an extensive development plan with resources of Mk 115 million for the years 1991-95. This and other proposals will be discussed later.

Steering mechanisms for researcher training

The Higher Education Development Act requires the Council of State to approve, every four years, a development plan for the institutions of higher education for the year of approval and for the five subsequent years. A plan for the years 1991-96 with targets for researcher training was approved in 1991.

According to the plan, it is necessary to enhance researcher training and to improve its quality in order to ensure high-level research and to extend the impact of science to society as a whole. Internationalisation both increases the demand for researcher training and creates new opportunities for it.

The report sets an annual target of roughly 650 new PhDs at the end of the planning period (targets are also presented by discipline, see below). No targets are set for the number of licentiates, as the aim is for postgraduate education to lead directly to a doctorate.

By a letter sent to the institutions of higher education on 5 December 1991, the Ministry of Education confirmed the targets set for various fields and institutions of higher education. Minimum and maximum estimates were given. After the institutions of higher education have shifted to management by results (see below), the degree targets will be recorded in the state budget.

Degree requirements

The degree requirements for various fields of study have been defined by decree. Researcher training leads directly to a doctorate (PhD) or to an intermediate licentiate (master's).

The main content of most decrees is as follows: a person who wishes to pursue postgraduate studies for a licentiate or a doctorate should have an undergraduate degree in the field, an equivalent foreign degree, an undergraduate degree in another field, or sufficient knowledge and capabilities, otherwise acquired, to perform doctoral studies. Requirements for a licentiate include:

- familiarity with the field and its significance, as well as ability to apply scientific research methods independently and critically;
- familiarity with the development, basic problems and research methods of the disciplines related to the research field;
- sufficient knowledge of the relevant scientific theory.

If a student wishes to obtain a doctorate without first obtaining a licentiate, he/she should demonstrate mastery of these requirements.

The student aiming at a licentiate should:

- participate in licentiate studies as defined in the statutory order;
- write a licentiate thesis;
- complete other studies defined in the statutory order, which, together with the licentiate thesis, prove that the student has sufficient knowledge and capabilities.

In order to earn a doctorate, the doctoral student must:

- take part in studies arranged for the doctorate as defined in the statutory order;
- write a doctoral dissertation and defend it publicly;
- complete other studies defined in the statutory order, which, together with the doctoral dissertation, prove that the student has sufficient knowledge and capabilities.

By decree, the institutions of higher education have the right to award doctorates. Other institutions do not have this right.

Recruiting for researcher training

Competition for admission to basic university education is very fierce in Finland. In 1991, 78 600 students sought admission to institutions of higher education; 21 000 were accepted, of which 17 100 were new university students. Almost all fields of study have a restricted number of entrance places; it often takes two or three years to obtain admission.

In principle, all graduates with undergraduate degrees are eligible for postgraduate studies. Some faculties can set requirements regarding grades obtained for the undergraduate degree as a prerequisite for postgraduate studies.

Students are recruited for researcher training through competition for postgraduate places, *i.e.* for funding. They may receive assistantships, lower-level teaching tasks in the institutions of higher education, researcher posts for projects, as well as research associate posts of the Academy of Finland. Large high-quality research teams tend to recruit talented students during their undergraduate training.

Progress of studies

Although emphasis is placed on the doctorate, most postgraduates still take the licentiate as an intermediate degree. This is probably due to the length of postgraduate studies in Finland. The intermediate degree provides at least some evidence of postgraduate study.

A study plan is usually drawn up for the postgraduate student, and a supervisor is appointed for the doctoral dissertation. The faculty usually also arranges a licentiate seminar in which postgraduate students present their licentiate theses. Other kinds of teaching may also be provided by the faculty or larger departments. National researcher training courses, recommended by the Postgraduate Training Committee, were arranged in 1992 in about 40 different fields. They were financed by the Academy of Finland, institutions of higher education, and private foundations.

Most of the time devoted to postgraduate studies is taken up by the preparation and writing of a doctoral dissertation. The doctoral dissertation is expected to be independent work, and in Finland, this has led to overemphasis on work done by the PhD student alone. In 1988, 75 per cent of the writers of doctoral dissertations said that they had done the work alone, and only one-quarter were engaged in research projects. Most doctoral dissertations prepared within research projects were completed in technology, and even then the percentage was only somewhat over one-third.

Postgraduate students often find the doctoral dissertation supervisor's contribution insufficient and sometimes entirely lacking. The majority of those who earned their doctorates in 1988 were dissatisfied with the supervision they had received. In many fields, particularly in the humanities, doctoral dissertation requirements are often very high. Several development plans propose that the requirements be eased without a drop in quality.

For the public defence of a doctoral dissertation, a book or a collection of articles must be published; and a certain number of copies, specified by the university, must be publicly available. As a rough estimate, doctoral dissertations are published as follows: under one-half are published by the higher education institution where the dissertation was approved; one-fifth by learned societies; 1 per cent by private printing houses; and the remainder in other places, such as research institutes or author's editions. About half of those who obtained their doctorates in 1988 paid at least part of the printing costs of the doctoral dissertation. The defence of a doctoral dissertation is often delayed by the printing of the dissertation and the need to find funding for it.

The quantitative development of postgraduate degrees

Several efforts have been made to evaluate the need for PhDs in Finland. Three studies, ordered by the Ministry of Education, have been made – in 1973, 1979, and 1989 – on the need for researcher training. The latest, drawn up for the Postgraduate Training Committee headed by Chancellor Lehto, investigated needs by the year 2000. At the Academy of Finland, Räty (1988) has studied professors' retirements to 2007. Various committees or standing advisory boards have also paid attention to researcher training when drafting plans for higher education training.

Separate estimates on the need for PhDs have used the so-called workforce method, *i.e.* estimating the need for doctorates in the target year 2000. Estimates are made first of losses from the research system due to the age structure, then of changes arising from increases in the research system, and finally of changes caused by mobility among researchers.

The estimates of the need for PhDs prepared for Chancellor Lehto's Postgraduate Training Committee suggests three possibilities. One is a need for at least 450 new doctorates annually. Estimates for various growth targets of the research system see the need for 500-550 new doctorates annually. Chancellor Lehto's committee set a target of 600 new doctorates annually.

For the number of new doctorates, the Council of State set the following targets for the year 1996:

Theology and humanities	50-60
Education and psychology	25-30
Economics, law, and social sciences	55-70
Natural sciences and agriculture and forestry	150-165
Technology	100-130
Medicine, dentistry, veterinary medicine, public health science, pharmacy and physical training	165-180
Music, industrial arts, theatre	5-10
Total	550-650

Estimates of the need for doctorates have continually risen. The higher education institutions will shift to management by results in 1994. They will be able to decide on their use of resources, but the targets will be set outside. Central quantitative targets include the number of degrees to be earned, including doctorates; these will be recorded in the state budget for institutions of higher education.

Growth in the number of PhDs

Figure 3.1 shows the number of doctorates earned in 1975-92 along with the targets set by Chancellor Lehto's committee. The number of doctorates has increased continually from 1975. With the growth of the higher education institutions and the research system, the number of doctorates earned increased to 1982 but tapered off towards the end of that

period. In 1982-86, the curve formed a W-shaped depression, a delayed reflection of the stagnation in science policy and research funding in the late 1970s. When funding increased in 1980, the number of doctorates also began to increase. In 1989-91 the total number of doctorates rose considerably (see Table 3.1).

Figure 3.1. **Doctorates earned in 1975-92 compared with the targets set by the Postgraduate Training Committee**

Source: Author.

Table 3.1. **Number of doctoral dissertations defended in institutions of higher education (1989-91) and the targets of the Postgraduate Education Committee for 1995, by main fields of science**

	Dissertations			Target
	1989	1990	1991	1995
Humanities	39	56	53	60
Social sciences	59	83	80	90
Natural sciences	94	132	119	130
Agriculture and forestry	16	22	24	30
Technology	45	54	83	120
Medical sciences	145	158	168	170
Total	398	505	527	600

Source: Author.

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Attempts have been made to explain the rapid increase in numbers of doctorates. Research funds increased considerably in the late 1980s, particularly in institutions of higher education. In 1990, the oldest university in Finland, the University of Helsinki, celebrated its 350th anniversary, and all faculties organised conferment ceremonies. Many doctoral candidates hurried to finish their dissertations in order to attend the ceremonies.

The number of PhDs is probably most affected, however, by the fact that the number of degrees conferred is used as an indicator for allocating appropriations among institutions of higher education. The degrees earned are defined as results, and doctoral degrees are valued at ten times the value of undergraduate degrees. Several institutions of higher education use the same indicators for the internal allocation of funds.

The duration of researcher training

Researcher training is very lengthy in Finland. According to a survey made for Chancellor Lehto's committee, students who earned their doctorates in 1988 spent, on average, ten years between the undergraduate degree and the doctorate. The average length for those working in institutions of higher education was ten years, for those working in research institutes, it was 9.5 years, and for those engaged in other work, 13.1 years.

The age of those earning PhDs has also been studied. In 1988, the average was 36 years of age. The age at earning the doctorate has risen continually: in 1975-79, the median age was 34; in 1980-85, it was 35; and in 1985-88, 36 years. A similar trend is observed in the main fields of study, although there are differences among them. The average age has risen most in the social sciences, by about five years, and the median age of doctorates is highest in the humanities, at 40 years of age. The youngest PhDs in recent years have been in technology, at 34 years. Those earning their doctorates in the natural sciences, in agriculture and forestry, and in medicine are about 35 years of age.

There are also great variations within the main disciplines. In mathematics, PhDs are earned at 31 years on average, with a rise of only a year. In chemistry, on the other hand, the age of doctorate recipients has risen by almost five years, to an average 38 years of age. Compared to the late 1970s, the age has declined in technology, geography, biology, and veterinary medicine. It also takes a long time to obtain an undergraduate degree in Finland, six to eight years, on average, and undergraduate studies often start two to three years after matriculation (secondary education).

* Surveys show that the length of time between the undergraduate degree and the PhD has increased. There are at least two reasons. Conditions have changed in the universities, and, as a result, it takes more time to complete a doctoral dissertation. As few professorships have become vacant, more and more doctors hold assistant posts in higher education institutions. Also, there may be changes in the nature of doctoral dissertations or in the way they are prepared, as a study conducted in the social sciences suggests.

Funding of researcher training

A survey was carried out for Chancellor Lehto's committee in order to learn how persons earning their doctorates in 1988 had funded their studies. Finland has no uniform system for the funding of doctoral studies, and doctoral candidates had therefore worked, on average, for ten years during their studies. Circumstances under which doctoral dissertations were prepared are as follows:

Institutions of higher education	50.5
Other Finnish universities	3.7
State research institutes	8.0
University hospitals	14.0
Other public administrations	4.7
Private research institutes or associations	2.7
Foreign research institutes	5.3
Business enterprises	3.0
Own	8.3
Total	100.0

In the main, doctoral dissertations were written in institutions of higher education, and 51 per cent of respondents had prepared their doctoral dissertations in the institution of higher education where they had obtained their undergraduate degree. Only 4 per cent had done the doctoral dissertation in another Finnish institution of higher education. Those working in institutions of higher education had been engaged in teaching and research for almost the entire period, those who did their dissertations in research institutes were employed by the research institute, and the others were employed either by university hospitals, where many doctoral dissertations in the medical sciences were prepared, or by the public administration. There was very little mobility between the research institute and institutions of higher education.

Halinen (1989) investigated the time available for preparing a doctoral dissertation in different positions (Table 3.2). As there are few opportunities for concentrating fully on doctoral work (research posts of the Academy of Finland, scholarships, studies abroad), Halinen developed a full-time indicator in order to estimate the probable length of doctoral studies on a full-time basis. According to this indicator, doctoral studies took on average 4.6 years (5.6 in institutions of higher education and in research institutes, and 3.4 in other tasks), and, on that basis, the target of four years was almost reached.

About one-third of those earning their doctorates in 1988 were obliged to obtain additional funds for their studies, either from relatives or by taking out a bank loan. This form of funding was used particularly for attending congresses and for researcher training abroad.

Table 3.2. **Employment between the undergraduate degree and the doctorate: time (years) and share (percentage) of the total time devoted to employment**

	Total	
	Time	Share
Teacher in institution of higher education	2.9	26.1
Researcher in institution of higher education	1.2	11.1
Scholarship researcher	0.4	3.9
Researcher abroad	0.3	3.1
University hospital	1.1	9.8
State research institute	0.4	3.9
Other public administration	3.0	27.4
Private research institute	0.1	1.2
Private enterprise, private entrepreneur or association	0.9	8.4
Military service, civilian service, or parental leave	0.3	3.0
Retired, sick leave, unemployed or otherwise out of work	0.2	2.2
Total	11.1	100.0

Source: Malinen (1989)

Internationalisation of researcher training

Of those who earned their doctorates in 1988, 5 per cent (16 persons) took their degree abroad: five in the United States, two in Germany and in Japan, one in Israel, and the rest in other European countries. Seven of the dissertations were in the field of technology. In addition, 30 per cent of those who earned their doctorates in 1988 had performed part of their researcher training abroad (the share was 20 per cent in the 1973 survey). The Academy of Finland and private funds and foundations are the most important funders of researcher training abroad.

Encouraged by international evaluations of different fields of science, the Academy of Finland started to fund researcher training abroad in the late 1980s. Table 3.3 shows the number of recipients for 1990-91, a figure that has remained relatively constant for several years at approximately 200 per year. The United States plays a significant role in researcher training, particularly in the medical sciences.

Co-operation in researcher training with Central and Eastern Europe has been rare. Contacts with these countries have been organised mainly through bilateral agreements between academies of science and the Academy of Finland and through agreements signed between Finnish and foreign institutions of higher education. The average length of researcher visits on both sides has been very short, ranging from a few weeks to some months. In the past few years, there has been growing interest in co-operation for researcher training with the Baltic countries, particularly with Estonia.

Foreign teachers have participated in researcher training, particularly through courses. Lectures and seminars have been organised for PhD students in connection with

Table 3.3. **Researcher training abroad, funding decisions for Academy of Finland appropriations, by country groups and research councils (excl. exchange scholarships), 1990-91**

	United States and Canada		EU States		EFTA		Central and eastern European countries		Others		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Central board	1	9	6	55	–	–	–	–	4	36	11	100
Humanities	15	32	26	55	1	2	2	4	3	6	89	100
Natural sciences	60	46	48	36	4	3	–	–	20	5	171	100
Medical	57	76	11	15	3	4	–	–	4	5	124	100
Agriculture and forestry	19	50	12	32	1	3	–	–	6	16	56	100
Technology	28	45	22	36	8	13	–	–	4	6	82	100
Social sciences	34	50	23	34	6	9	–	–	5	7	105	100
Environmental sciences	11	58	6	34	1	5	–	–	1	5	29	100
Total	225	50	154	34	24	5	2	1	47	10	452	100

Source: Author

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researcher visits. Finnish researchers also attend international researcher training courses, arranged, for example, by the *Nordisk Forskarutbildningsakademi*, the European Science Foundation, or the European Environmental Research Organisation.

In the past few years, foreigners have shown a growing interest in studying in Finland, and in 1991, there were some 1 900 foreign students. About one-quarter were in the humanities, probably owing to the training available in Finnish and the Finno-Ugric languages. No statistics on the number of foreign doctoral students are available. The Helsinki University of Technology has 170 foreign postgraduate students, primarily from the developing countries; half are from China. Internationally-known research teams always recruit foreign postgraduate students. Teaching in English is important for improving study conditions for foreign students. A plan concerning high-quality postgraduate studies intended for foreign students is presently being prepared by the Council of University Rectors.

Most holders of PhDs work in the public sector, which includes institutions of higher education, state research institutes, and health care services (*e.g.* university hospitals). Industry has rapidly increased the number of PhDs among its employees; in 1985 only 7 per cent worked in industry. Industry invested very vigorously in R&D in the late 1970s. The Finnish Employers' Confederation has compiled statistics on the number of doctorates in its member enterprises.

Placement of holders of doctorates

Table 3.4 shows the placement, by fields, of holders of doctorates in 1970, 1980, and 1985. Of about 800 engaged in working life in 1990, approximately 20 per cent were employed by the member enterprises of the Finnish Employers' Confederation, 50 per cent worked in institutions of higher education, and 20 per cent in other parts of the public sector. Table 3.5 shows where those who earned their PhDs in 1988 worked roughly one year after defending the doctoral dissertation.

Co-operation with business and industry

As noted above, few holders of doctorates work in business and industry. Many studies indicate that one reason for this is the low prestige attached to researcher training by business and industry.

In 1984, the Academy of Finland initiated industrial researcher training in co-operation with industry. The Academy of Finland selected those to be trained and funded them jointly with the employing industrial enterprise. At first, some ten postgraduate students were accepted into the programme annually. Particularly during the first years, persons who had worked in industrial research for a long time but lacked formal competence sought to enter the programme. A follow-up study conducted in 1988 showed that one-half of those who completed their training had earned the doctorate. The work had taken more time than expected, and some found writing the dissertation too difficult.

Table 3.4. **Doctorates, master's degrees and their share in the economically-active population, 1970, 1980 and 1985**

	Doctorates	Master's degree	Share in the economically-active population in the field
Industry			
1970	224	10 704	2.1
1980	412	19 612	3.6
1985	612	24 533	4.8
Business			
1970	149	5 689	8.1
1980	294	11 924	10.3
1985	416	19 204	12.7
Public service			
1970	3 211	30 467	8.8
1980	5 800	51 476	10.4
1985	7 379	65 595	11.2
Other			
1970	152	9 405	0.8
1980	301	16 109	1.6
1985	356	21 875	2.3
Total			
1970	3 736	52 265	2.8
1980	6 807	99 121	4.8
1985	8 763	130 907	6.1

Source Author

Industrial researcher training has been expanded into enterprise researcher training and is jointly funded by the Academy and the enterprise concerned.

Industry interest in R&D grew in the late 1980s. Kemira, a large chemical firm, established "industry academies" in co-operation with some higher education institutions, in order to initiate and carry out research and researcher training. Nokia, an electronics firm, embarked on an in-house researcher training programme involving teachers from institutions of higher education. Two large banks have also supported researcher training, and at least one doctoral dissertation has been completed with this support. Several licentiate theses and some doctoral dissertations are being prepared within the Kemira co-operation.

A project entitled Academy of Business and Industry was initiated by the Finnish Employers' Confederation. The goal was to train Finnish experts for fields that lack or have insufficient scientific expertise. It has encountered great difficulties owing to the strong differences between the interests of business and universities. In offering research tasks and most of the resources to institutions of higher education, industry expects to

Table 3.5 **Employment of 1988 PhDs one year later**

Professor	2.7
Associate professor	3.7
Lecturer	5.3
Senior assistant	2.7
Assistant teacher	2.3
Assistant	14.6
Researcher in higher education institution	6.0
Researcher or teacher in other institution	5.6
Academy of Finland post	6.0
Researcher in foreign higher education institution	2.3
Higher education institutions, sub-total	51.2
State research institute	5.6
University hospital	13.3
Other public administration	6.9
Health care sector	8.3
Association or foundation	2.7
Private enterprise or private entrepreneur	8.3
Work abroad (not higher education institution)	2.0
Unemployed or voluntarily out of work	1.7
Total	100.0

Source: Author.

benefit from the results. Conflicts of interest between higher education institutions and industry cannot be avoided.

Institutions of higher education carry out some commissioned research for industry. Researcher training can be arranged within the projects funded by industry on topics of interest to industry.

Co-operation with business and industry is very sensitive to economic fluctuations. No data is so far available regarding the impact of the current deep recession on this co-operation.

Several researchers who previously worked in industry have applied for vacant research posts at the Research Council for Technology of the Academy of Finland. The Research Council has also increased its funding to postgraduate students.

Training after earning a PhD

In the last few years, the Academy of Finland has started to fund postdoctoral studies, primarily abroad. Funding has been given especially in the medical sciences.

There are no special training arrangements for holders of doctorates. They take part in researcher training courses in Finland and abroad, especially those arranged by interna-

tional bodies. The number of posts falling between professorships and assistantships in higher education institutions has increased considerably in the last few years (421 in 1988, 603 in 1991). Holders of these posts usually have PhDs. A large number are assistantships which have been transformed into senior assistantships.

Discipline-specific features

Regarding the quantitative targets set for researcher training by Chancellor Lehto's committee, there is a need for more doctoral students, particularly in the fields of technology, economics, education, and agriculture and forestry. In almost all other fields, targets have almost been met, but for technology especially, the gap between the target and the number of PhDs remains wide

In some new and important fields, researcher training programmes have been initiated and funded by the Academy of Finland. The programmes have usually included the arranging of researcher courses and covered salary costs of doctoral students employed in Finnish or foreign research teams. The first programme was in the field of biotechnology, and the programmes usually last from three to five years. At present, there are seven programmes, in fields such as materials research, information science, ecotoxicology, and space research. .

In terms of researcher training, there are great differences among disciplines. The problems encountered in certain fields are described below.

In the humanities, the excessive length of studies and the insufficient number of researchers, in modern languages in particular, are among the most important problems. There are several postgraduate students in the field, many of them part-time. Competition for postgraduate training is strong and the requirements for doctoral dissertations are still high. The university departments are small.

In the arts, researcher training is being initiated and is still seeking appropriate forms. Contacts with relevant research in universities are important, as are postgraduate studies in the art academies.

The social sciences have a large number of postgraduate students, and competition for university posts is strong. As a result, doctoral students or recent recipients of the PhD remain in place, and mobility is scarce. Studies in the social sciences traditionally provide good methodological training, but the writing of the doctoral dissertation is often insufficiently supervised. In addition, because of competition, requirements for the dissertation have increased unreasonably in all social sciences.

The field of law has many problems. Compared to the estimated need, too few PhDs are earned. The time required for obtaining a doctorate is long. Doctoral dissertations are large, methodological training is scarce, and supervision insufficient. Researcher training does not enjoy sufficient prestige within the judicial system and government. On the other hand, structural changes occurring in society, the economy, and technology, as well as internationalisation, increase the need for legal research and for scientific expertise.

In economics, the greatest problem is that persons seeking entry into the field are often uninterested in research. A nation-wide co-operation programme has existed for

years, with good results. Supervision of research work should be enhanced. Sufficient extramural funding for researcher training has been available.

In the natural sciences the general situation is relatively good. Interest in postgraduate studies is great, and the number of doctorates earned is quite large. In some fields, however, the time taken to earn a degree is very long. International contacts are good in most fields. In the most rapidly developing fields, fixed-term special programmes for researcher training are needed.

There are great qualitative and quantitative differences in researcher training in technology. In research-intensive high-technology fields, researcher training is of high quality and is efficient, and there is interest in postgraduate studies. In many traditional fields of technology, however, there is almost no researcher training and doctoral dissertations are often written alongside regular work and without supervision, and this is shown in the quantity and quality of the doctoral dissertations. There are generally sufficient training positions, but salaries are much lower than in industry.

In the medical sciences, the general situation is relatively good. In some fields there is, however, a great shortage of postgraduate students as well as a lack of research training and supervision, and special support is needed. In the clinical fields, too few researcher training positions are available, and more emphasis should be placed on researcher training both by doctoral students and their supervisors.

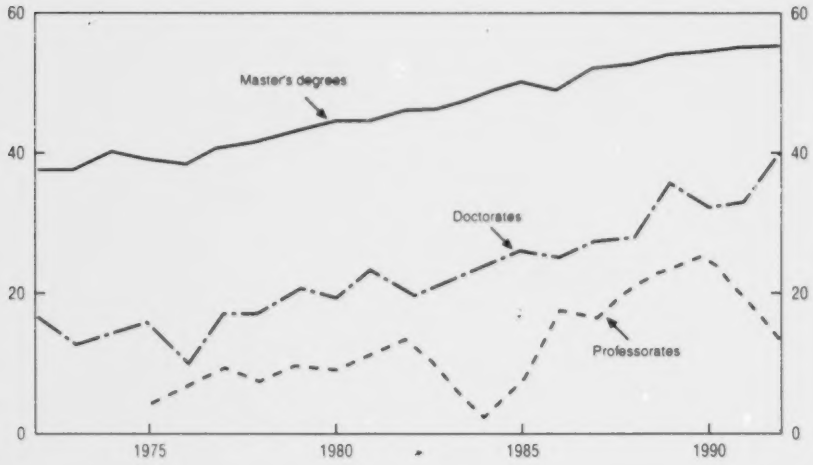
Women's share in researcher training

Figure 3.2 shows the share of women earning master's degrees and PhDs in 1970-90. Women have long accounted for nearly one-half of undergraduate degrees, and their share exceeded 50 per cent in 1987. Women's share of doctorates remains small, however. A committee was formed by the Ministry of Education in 1981 to investigate barriers to, and problems of, research careers for women. No actual barriers were found, but entry into researcher training and research careers was hampered by informal norms and practices in the scientific community. The Academy of Finland has regularly collected information on the number of women in doctoral programmes, their age structure, and their entry into the ranks of professors of institutions of higher education (Räty, 1991).

Women's share of PhDs has increased relatively steadily. In 1976-81, there were still fields lacking women with doctoral degrees, but in the past few years women have been active in fields traditionally occupied by men, such as data processing and forestry. Of those earning PhDs in 1986-90, 29.5 per cent were women. But whereas 10 per cent of men with a master's degree continued on towards a doctorate, only 5.8 per cent of women did so.

In a survey of persons who earned PhDs in 1988, women were studied separately. The length of time between the undergraduate degree and the doctorate was 3.5 years more for women than for men. Women worked in institutions of higher education longer than men. The difference is not explained by maternity leaves alone. However, women relied more on part-time studies than men. In 1988, no woman earned a doctorate abroad.

Figure 3.2. **Womens' share of basic degrees, doctorates and professorates**



Source: Räty (1991).

Future prospects of researcher training

Finland's economic growth slowed in 1990 and entered a deep decline in 1991. The unemployment rate rose to 15 per cent. Tax revenues no longer covered the greatly enlarged public sector, and the state rapidly went into debt. As a result, the government decided on certain retrenchment measures and made plans to cut back in the public sector. Its target was to decrease personnel employed by the state by 5 per cent by the end of 1995. Decisions on other economy measures have also been made.

State research expenditure decreased in real terms by 4.4 per cent in the 1993 state budget. The reductions were targeted at research performers as follows:

Institutions of higher education	7.9
The Academy of Finland	8.3
The Technology Development Centre	7.9
State research institutes	8.1
Others	3.2
Total	4.4

The Higher Education Development Act, which, as a minimum target, assures the maintenance of the real value of the resources of higher education institutions, has been

temporarily abrogated. Institutions of higher education must reduce their staff by 1 080 persons by 1995. These measures have created great anxiety among personnel.

The institutions of higher education cannot cope with the reductions by across-the-board cuts. Structural adjustment is needed. To this end, the Ministry of Education is revising the development plan for training and research in higher education institutions for 1991-96, that was previously confirmed by the Council of State. The revised plan will address the division of labour among institutions of higher education and clarify the division of labour among institutions of higher education and vocational higher education institutions; it will also address the issue of increased co-operation among institutions of higher education and the termination or reduction of activities less significant to society. The plan was discussed by the Council of State in April 1993.

In practice, the plan will mean the abolishment of certain university entities or parts of them. A stand should also be taken regarding degree targets, which are heavily based on increases in research activities in the public sector. According to the statistics of the Ministry of Labour, the number of unemployed PhDs has been about 110 since the latter part of 1992 and the beginning of 1993. Out of this number, some 45 are foreigners. There are unemployed PhDs in all fields of science, the largest number being in the natural sciences and medicine, where the number of foreigners is also highest.

In Finland, state offices will shift to management by results by 1994. Individual units will take responsibility for deciding how to arrange their activities and reach their targets. The Ministry of Education's power to direct structural change will thus be reduced, and the combining or termination of various units will be very difficult, unless the institutions of higher education themselves see the necessity for reforms.

Conclusions

Efforts to increase researcher training have been good, and the number of degrees earned has increased steadily. The only field lagging behind its target is technology. The time required to obtain a doctorate is still long, and the median age of recipients is high. This is due to poor opportunities for full-time doctoral studies. Full-time studies are made possible by Academy of Finland research posts, project funding, scholarships from foundations, and doctoral studies abroad.

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Chapter 4

RESEARCH TRAINING IN ITALY

by

Sveva Avveduto

National Research Council Institute for Studies on Scientific Research and Documentation

University research training

In Italian universities, training for research, as a formal set of courses for postgraduate students, is a rather recent phenomenon. Only in 1980 was a system of postgraduate education set up as an independent course of study leading to postgraduate qualification in research. This does not mean, of course, that there was no previous system of training and selection, as preparation for an academic career, including research, has always been one of university's goals. There were various channels for preparing an academic career through university assistantships and fellowships and the eventual attainment of the *libera docenza*, which qualified the recipient for university teaching and research. The expansion of mass higher education during the 1970s dramatically changed the scene. The loss of the relative advantages of an elitist and self-reproducing system had consequences that affected both the organisation of study programmes and appointment to university positions. The link between a university degree and a good position on the labour market weakened, and as an academic career became accessible to more applicants, the numbers of applicants exceeded the number of available positions. The University Reform Act, passed in 1980, introduced a number of changes and regulated access to an academic career.

With the same Act, PhD programmes (the *dottorato di ricerca*) were introduced into the Italian system. The model adopted is a peculiar mix of rigidity and autonomy. Although it is only ten years old, it has already undergone a number of changes and, under pressure from both faculty and doctoral students, more changes are to come. What follows describes the present structure of university doctoral studies and the changes that may be introduced by the legislation currently under discussion.

The degree structure in Italy

Higher education is provided essentially by universities, which are almost entirely publicly-funded and run. Private higher education, although growing fast (especially for certain segments, such as business schools), has traditionally played a minor role. As a result, higher education has been very centralised and uniform. Students take courses and have to pass a number of examinations (depending on the discipline, from 20 to 33 over four, five or six years) in order to obtain a university degree (*laurea*, ISCED level 6). In a given discipline, the programme is the same in all universities throughout the country, and the number of examinations and the amount of compulsory course work is largely determined by the central education authority. The main reason is to guarantee that all students receive the same "amount" of knowledge and that the degrees awarded represent the same work in all universities. The quality of courses, professors, and facilities naturally affect the end result, but, at least in principle, the state offers equal possibilities to all.

This centralised and rather rigid system has affected the structure of doctoral education, which, as originally conceived, left very little autonomy to individual universities. As will be shown below, this conception has created many difficulties, and a number of substantial changes are now under discussion, both for doctoral programmes and for the university sector in general.

The higher education sector has well over a million students (1 381 391 in 1990/91), almost equally divided among men and women (Tables 4.1 and 4.2). In some disciplines, the ratio is very unbalanced (*i.e.* men prevail in engineering and women in the humanities). However, a large number of students leave the university after the first year, and only 30 out of 100 ultimately receive the *laurea*.

Depending on the discipline and the rules formulated by the faculty, undergraduate students may or may not be obliged to attend lessons and laboratory work and participate

Table 4.1. **Number of students in Italian universities, 1990-91**

	Men	Women	Total
Agriculture	20 982	10 063	31 045
Economics and business	139 812	100 288	240 100
Law	113 942	124 808	238 750
Engineering	180 493	51 190	231 683
Humanities and languages	60 373	225 349	285 722
Medicine	465 577	38 069	84 646
Mathematics, physics and natural sciences	79 356	81 012	160 368
Political science	46 939	43 511	90 450
Diplomas (ISCED level 5)	9 102	9 525	18 627
Total	697 576	683 815	1 381 391

Source: National Institute of Statistics (ISTAT)

Table 4.2. **Number of graduates (ISCED level 6) in Italian universities, 1990**

	Men	Women	Total	% variation from 1989
Agriculture	1 902	740	2 642	-8.3
Economics and business	7 974	4 582	12 556	8.1
Law	7 019	6 647	13 666	8.8
Engineering	9 359	2 381	11 740	-1.1
Humanities and languages	3 229	14 633	17 862	7.2
Medicine	6 692	4 475	11 167	-8.5
Mathematics, physics and natural sciences	5 005	6 602	11 607	-0.7
Political science	2 238	2 333	4 571	7.8
Diplomas (ISCED level 5)	1 538	2 132	3 670	-8.2
Total	44 956	44 525	89 481	2.0

Source: National Institute of Statistics (ISTAT).

in seminars. Rather paradoxically, Italy's centrally-governed system has no specific rules concerning involvement of students in research activity, so that in many cases, involving or ignoring students is left up to professors. In the "hard" and experimental sciences, it is common practice to involve students, but most often professors transmit knowledge rather than actually involve students in research activities.

The structure of doctoral studies

The present organisation and structure of doctoral studies can be outlined as follows:

- *Objectives:* Doctoral studies are aimed at developing research capabilities and activities leading to the production of original scientific results.
- *Organisation:* To be admitted, graduate students (either Italian or foreign) must take written and oral tests in order to determine their aptitude for research.
- *Length:* The course of study lasts a minimum of three years. During this time, students can do part of their training and research outside the university, either in an Italian research institution or in a foreign university or research institution. This period, to be agreed with the director of the programme, can vary in length; it usually lasts six months, but can be prolonged if required, providing it does exceed not half the total time devoted to the doctorate.
- *The course of study:* PhD studies are a mix of individual research activity and attendance at specific courses and seminars. At the end of the programme, the candidate defends a dissertation on his/her research subject, which is chosen by the candidate with the agreement of the professors of the department organising the programme.
- *Planning and distribution of doctoral courses:* Initiating a doctoral programme at a university involves a number of steps. It is the ultimate responsibility of the

central authority for education to decide whether or not to allow the university to set up the programme. The decision is taken in light of the requirements of scientific research and science policy trends, in both the public and the private sectors.

The procedure for setting up a doctoral programme has the following steps. The Vice-Chancellors ask the Ministry of Universities and Research for formal approval to organise the programme. They must present both the programme of courses and evidence of the presence of high-level professors, structures, facilities, and instruments for organising and running them. The proposals are examined by the National University Council (CUN), composed of university professors and researchers, which advises the Minister of Universities. On that basis, the minister decides upon the total number of programmes to be initiated and allocates them among the various universities.

Each programme must be attended by no less than three and no more than ten postgraduate students. However, a university can increase this number by drawing up agreements with research institutions that provide additional funds to finance additional PhD positions (see below). The number of student positions initially assigned to each doctoral programme must be reconfirmed for later cycles.

It is possible to organise a doctoral programme consortium with other universities. Originally conceived as a way of favouring smaller universities, this has led in some cases to associations of so many universities that problems of distance and logistics made it impossible to co-ordinate the programme effectively. The recent trend is to restrict the number of universities that can form a consortium to a maximum of five, although it is strongly recommended not to exceed three. However, the possible cross-fertilisation arising from such associations should not be underestimated. The present associative structure might evolve in the direction of research schools, such as those existing or planned in Germany and in the Netherlands.

An official document issued by the Ministry of Education in 1986 (*Ministero della pubblica istruzione*, 1986), at the time responsible for graduate and postgraduate education, presented the most important issues concerning doctoral studies. The document defined the characteristics of doctoral programmes in order to distinguish them clearly from other postgraduate studies in university schools of specialisation. The latter provide professionally-oriented programmes in a wide range of disciplines; their aim is to impart specific professional capabilities, but not necessarily scientific research capabilities. The doctoral programmes, instead, emphasise scientific research. The diploma awarded in the schools of specialisation is formally recognised and necessary for the relevant professions (particularly the medical ones), whereas the PhD receives no such recognition. The same official document indicates that the PhD requires a different organisation of teaching and research activities from undergraduate studies and from the previous organisational structure of postgraduate academic work. It underlines the importance of individual involvement in designing the course of study and research and the development of specific activities, such as workshops and seminars, for postgraduate students. The need to give guidelines to explain how, and in what respects, doctoral programmes differ from undergraduate courses and the schools of specialisation shows the novelty of the pro-

grammes and explains why the universities found it difficult to harmonise them with the existing structures.

Some figures on the Italian PhD

Research fellowships for doctorates have been available at universities since 1983. The available positions have generally been awarded for cycles (each lasting three years, the time generally required to obtain the doctorate), and information on numbers of students or various aspects of the doctorate generally refers to cycles rather than to years. Because this may be confusing in an international context, the beginning of the cycles are here converted to correspond to certain years:

First cycle	1983
Second cycle	1985
Third cycle	1986
Fourth cycle	1987
Fifth cycle	1988
Sixth cycle	1990
Seventh cycle	1991
Eighth cycle	1992

Between the first doctoral programme and the last figures available, the number of PhD positions in universities and of doctorates awarded has evolved (see Table 4.3). Over the first five cycles, 12 500 PhD positions were created, with an average of 2 000 per cycle and a peak, in the fourth cycle, of 3 600 posts, owing to the strong increase in medicine and the natural sciences. From the sixth cycle onwards the number of posts has almost doubled, with approximately 4 000 for each cycle.

The turning point was the spectacular increase in some disciplines between the fifth and sixth cycle. The total number of posts was increased from 2 500 to nearly 4 000, with the number almost doubled in disciplines such as economics, law, and veterinary medicine, and rising by about one-third in engineering, the humanities, and medicine. Since then, the number of posts available has remained fairly constant, except in medicine, where posts have tended to decrease over the three last years, and architecture and economics, where they have increased. As stated before, these changes are decided by the Ministry of Universities and Research on the basis of an evaluation of needs, as determined by recent trends.

The number of degrees awarded (Table 4.4) concerns the first four cycles. There are now 5 119 PhDs in Italy. Over 2 000 are in the medical field and in mathematics, physics, and the natural sciences. Nearly 1 000 are in the humanities, over 600 in engineering, with the rest in the remaining fields.

In addition to these figures, derived from the Ministry and Cineca, the accredited data collecting and processing institution (Cesaratto *et al.*, 1994), it seems useful to add some information on the first results of an extended analysis of Italian doctorates carried out by the National Research Council, which is still in progress. Only the results relevant to the aims of this paper will be presented here, particularly those concerning employ-

Table 4.3. **Number of doctorate positions available in Italian universities**

	1983 (1st cycle)	1985 (2nd cycle)	1986 (3rd cycle)	1987 (4th cycle)	1988 (5th cycle)	1990 (6th cycle)	1991 (7th cycle)	1992 (8th cycle)
Agriculture	75	75	95	202	112	173	171	163
Architecture	60	57	41	113	80	137	159	175
Economics and business	86	78	87	147	127	266	296	341
Pharmacy	39	39	49	100	65	99	102	103
Law	136	137	125	169	156	290	294	304
Engineering	283	269	309	572	390	642	657	666
Humanities and languages	364	333	344	439	410	637	632	650
Medicine	459	467	474	832	556	805	779	660
Veterinary	33	34	36	83	48	80	85	87
Mathematics, physics and natural sciences	466	448	481	881	550	748	724	751
Political science	74	81	64	79	75	115	113	107
Statistics and demography	22	20	25	25	20	1	1	1
Total	2 097	2 038	2 130	3 642	2 589	3 992	4 012	4 007

1. Included in political science.
Source: Ministry of Universities and Research/Cineca.

Table 4.4. **Number of doctorate positions available and of doctorate degrees awarded in Italy (from 1983 to May 1992)**

	Number of positions available	Number of degrees awarded
Agriculture	1 067	221
Architecture	840	163
Economics and business	1 312	167
Pharmacy	596	102
Law	1 611	281
Engineering	3 789	612
Humanities and languages	3 809	951
Medicine	5 036	1 195
Veterinary	486	84
Mathematics, physics and natural sciences	5 055	1 132
Political science	708	169
Statistics and demography	228	42
Total	24 537	5 119

Source: Ministry of Universities and Research/Cineca.

ment, as no specific record is kept at national level on that topic. The survey analyses the PhD experience from both the institutional and the individual point of view. It was structured as follows. A questionnaire was mailed in 1992 to a wide random stratified sample of 3 000 PhD holders and doctoral students, to the 800 professors in charge of directing doctoral programmes in the fifth cycle, and to the 1 000 examiners of dissertation theses in the first, second and third cycles. The response rate was very high: over 50 per cent for doctoral students and over 40 per cent for both groups of professors. The survey covered various topics: personal information regarding the social background of students and families, marital status, nationality, previous studies or current other studies, work experience, and so on. A large part was devoted to the analysis of the organisation of courses, to aspects that met with satisfaction or dissatisfaction, and to problems encountered by students. The quality of courses and facilities (in comparison with experience abroad) also evaluated. A final part was devoted to employment of PhDs.

Status of PhD students

On the students' side, their main motivation for following the doctoral programme was the wish to enter a university career. Considerations relating to the social and professional status of PhD candidates are essential. All official documentation on doctoral programmes refers to "students", so that they are naturally perceived as students rather than as workers. The rules regulating their activities explicitly forbid them to act as lecturers or to perform any activity that could be called a university position. They are paid, but only to study and conduct research. However, it has proved difficult, if not impossible, and certainly not desirable, to exclude doctoral students from many activities that mark university life. In spite of the written regulations, they have been involved in teaching, contact with, and tutoring of undergraduate students and all sorts of activities that are part of routine university activities.

The push by doctoral students and the pull by faculty have led to a request for using these "students" as assistant lecturers. The new proposed doctoral regulations acknowledge these requests and would make it possible to employ doctoral students in support activities for lecturing and research, outside as well as in the university, and as tutors of undergraduate students. In terms of employment regulations, doctoral students have the same rights concerning conscription and maternity leave as any other worker.

The social and professional identity of doctoral students is directly linked to their functions and responsibilities. They are called students, although in fact they are in a position that fluctuates between student and professional worker and should more correctly be described differently. In the first cycle of doctoral training, doctoral students were expected to come from a mixed body of applicants, but the trend is now towards limiting the conditions for participation. In the first cycle, it was possible, by making a request two years in advance, to obtain the degree with a dissertation prepared autonomously; in addition, a number of positions were reserved for persons already working in research or public administration. At present, however, graduates without job experience and not enrolled in other courses of study are preferred. While this favours concentration

on one kind of effort and avoids dispersion, it also precludes interesting synergies which universities should pursue.

Labour market considerations

The main employment target for doctoral students is, of course, an academic career. However, the programme is not directly linked to an academic position, and it was clearly stated at the outset that obtaining the title did not ensure entry into the university. The act introducing the PhD stated that the title of doctor of research was to be considered as one scientific title among others. In the subsequent ten years, attitudes towards the doctorate have changed, both among students and at the policy level. Among students, expectations of an academic career have increased, owing to the strong emphasis on academic research in most programmes and to the personal orientation of participants. At the policy level, while the title is not a formal prerequisite for research jobs in universities, its value among the allowable credentials has risen. This means that entry into a university career is more likely if the applicant has received a doctorate.

Records on the employment of new recipients of doctorates have not been systematically kept at the national level. The results of the CNR survey mentioned above indicate that the situation of PhDs is quite good (Table 4.5). Over 72 per cent of Italian PhDs have full-time employment, 11 per cent are in temporary jobs, 12 per cent were awarded a postdoc fellowship, and 3.5 per cent are unemployed. Their situation is rather privileged when compared to the employment situation of young people in general and of university graduates: more qualified individuals seem to find employment more easily. Women have the weakest situation; the share of unemployed female PhDs is almost double that of total PhDs, and those employed tend to have occupations of lower status.

The employment breakdown (Table 4.6) shows the strong prevalence of employment directly linked to the university, although it is not as high as one might expect. Over 54 per cent of Italian PhDs are employed in universities (56.9 per cent of those fully

Table 4.5. **Employment situation of Italian PhDs**[1]

Percentage

Employment situation	Total	Women
Fully employed	72.1	66.9
Temporary	11.2	10.4
Fellowship	12.0	14.6
Not employed	3.5	6.1
Not available	1.2	1.9
Total	100.0	100.0

1. Number in sample: 911, of which 363 women.
Source: National Research Council, Survey of PhDs, 1993.

Table 4.6. **Employment of Italian PhDs**

Percentage

	Full employment	Temporary employment	Total share	Women
University	56.9	39.6	54.1	51.9
Public research institutions	6.1	8.9	6.4	4.9
Teaching	16.8	18.8	16.9	24.0
Government	9.0	7.9	8.9	8.5
Foundations	2.7	8.9	3.5	3.2
Business enterprise	3.7	2.0	3.4	2.5
Private research institutions	1.7	2.0	1.8	2.1
Professional offices	2.9	10.9	4.1	2.1
Other	0.3	1.0	0.8	0.7

Source National Research Council, Survey of PhDs, 1993.

employed and 39.6 per cent of those temporarily employed). A large number are employed in teaching (16.9 per cent) and a relatively large number (8.9 per cent) in the government sector. These relatively high percentages are related to the conditions of the first doctoral cycle, in which a share of positions was reserved for people already employed in public administration, in public research institutions, and in high school teaching. Many people took advantage of this opportunity, either for cultural reasons or to acquire new competence. Most of these people remained in their original sector and, according to the survey results, in the same function.

Few PhDs are employed in the business enterprise sector. Although Italian industry manifests interest in the doctorate, it offers few positions to PhDs. The main reason put forward by the industrial sector is the mismatch between the competencies of PhDs (who are highly specialised but rather old and too "academic") and industrial research's need for flexible people who are production-oriented and young enough to be reoriented or retrained to meet industrial requirements. One solution might be the "double curriculum" proposed by industrialists at a conference on the research doctorate and industry held by the *Accademia nazionale dei lincei* and the *Associazione italiana per la ricerca industriale* in 1990 – one linked to an academic doctorate and the other oriented towards applications and organised and run in co-operation with firms. To date, attempts to push the university towards industry, and vice versa, have been sporadic and tentative (as one example, Fidia Farmaceutica and ENI have organised a doctoral programme with the University of Pisa). On the whole, the business enterprise sector seems to be more interested in orienting short-cycle studies than in embarking on the much longer process of research training, with its uncertain results. Thus, IRI, one of the largest Italian industrial groups, has devoted much effort to specifying training for the three-year university cycle in engineering in order to orient it to industrial needs. In terms of employment, it is worth noting again that female PhDs have a greater share of the positions requiring lesser qualifications.

A particular sub-set that deserves special mention concerns those who participated in the programme while already employed. Nearly 60 per cent were employed in universities, 20 per cent in high school teaching, 10 per cent in public institutions, and the rest in the private sector. Receipt of the doctorate seems not to have been adequately rewarded, as 37 per cent of those already employed remained in the same position after receiving the doctorate; the figure is even higher for those with a temporary occupation (43.1 per cent), for women (41.7 per cent), and in certain sectors such as the humanities (56.1 per cent) and medicine (41.7 per cent).

The current organisation and content of research training outside the university

Research training and educational activities carried out by the main scientific institutions

The National Research Council

The National Research Council (CNR), is the most important national scientific institution carrying out research outside the university sector. Its budget and the number of its employees and associates make it the largest multi-disciplinary Italian scientific body. Its budget for 1993 was 1 100 billion lire; it includes 162 research institutes and 116 research centres attached to universities, and it has a permanent staff of 3 200 researchers and 2 795 technicians.

The CNR trains researchers and technicians, both for its own purposes and on behalf of other public and private institutions. This activity includes both courses run by Agency staff and the awarding of scholarships for study either in its facilities or in other Italian or foreign research agencies, as well as training contracts. It also runs a number of continuing education initiatives. The expenses for training activities in 1991 were L.57.5 billion, broken down as indicated in Table 4.7.

The research fellowships awarded by the Council each year are directed towards young graduates who seek a research career. Each fellow is attached to a CNR institute, has a supervisor, and participates directly in one of its research programmes. Fellowships may also be awarded by one of the CNR research projects (*progetti finalizzati*) or by the NATO scheme for junior or senior research fellows. As far as the doctorate is concerned, the CNR has devoted L 11 billion to financing the initiative. Table 4.8 presents the breakdown, by discipline, of PhD study financed by the CNR for the fourth and fifth cycles since 1987; the "hard" sciences predominate.

In 1985, the CNR planned a long-term programme to train highly qualified personnel in the Mezzogiorno, the less-developed southern region of the country. This initiative, generally aimed at the scientific upgrading of the area, has granted 1 720 fellowships for a training period of two or three years to young graduates living in the area.

A number of courses, schools, and seminars are organised by the various institutes in their area of competence. In 1989, 1 106 activities of this kind were organised for participants from both the organising body and from outside. Also, CNR personnel

Table 4.7. **National Research Council expenses for training activities, 1991**

	Billion lire
Fellowships	4.0
Doctorates	13.5
Project fellowships	12.9
NATO fellowships	1.9
Special plan for Southern Italy	25.2
Total	57.5

Source: 1991 National Research Council budget

Table 4.8. **Positions financed by the National Research Council since 1987**

	Number of positions
Mathematics, physics and natural sciences	152
Engineering	111
Biomedicine	105
Architecture	28
Agriculture	23
Law	17
Veterinary	13
Humanities and languages	12
Economics and business	11
Pharmacy	11
Political science and statistics	6
Total	489

Source: National Research Council, 1993

participated actively as teachers in courses, schools, and seminars organised by other institutions, involving some 145 institutes for a total of 6 597 hours of lectures. In 1989, about 1 800 persons were involved in educational activities within the CNR, nearly half of whom were undergraduates preparing their theses.

The CNR is a good example of the unavoidable connection between the production of science and its dissemination *via* the educational system.

The National Institute for Nuclear Physics

The National Institute for Nuclear Physics (INFN) is involved in fundamental research on nuclear and sub-nuclear physics. Its activities are performed in four national laboratories and in 19 sections located in the physics departments of Italian universities. The Institute's 1990 budget amounted to L 323 billion.

One of INFN's main peculiarities is its high level of integration with universities: it has both its own permanent staff (1 410 researchers, technicians, and administrative personnel) and associated university staff members (2 431 researchers and 303 technicians). The Institute has a strong influence on undergraduate and graduate students and young researchers in the field.

Educational activities directly performed by the INFN follow four main lines: permanent education of its staff members; a set of fellowships at different levels; the awarding of scholarships at the PhD level; and formal "association" with its research activities of many students preparing their theses, fellows of different institutions, and young researchers in general.

For its permanent education activity, the INFN had a budget of about L1 billion in 1990 but used only half of it. In the same year, it awarded 148 fellowships (see Table 4.9). In addition to these "high-level" fellowships, the INFN financed 127 PhD scholarships in physics for the period 1987-91; Table 4.10 gives evidence of the institution's increased interest in financing university doctoral studies. INFN's most unusual educational activity is its use of "association" (and part of its research budget) to support bright students and fellows from other institutions; in this way, the INFN made

Table 4.9. **National Institute for Nuclear Physics fellowships, 1990**

	Number of fellowships
Undergraduates	13
Young graduates	56
Postdoctoral fellowships	26
Foreign fellowships for Italian researchers	21
Fellowships in Italy for foreign researchers	22
Special fellowships for Chinese researchers	10

Source: National Institute for Nuclear Physics

Table 4.10. **Doctorate positions in physics financed by the National Institute for Nuclear Physics**

	Number of positions	Million lire
1987	16	750
1988	26	1 210
1989	25	1 120
1990	29	1 350
1991	31	n.a.

n.a. Not available
Source: National Institute for Nuclear Physics, 1992

it possible for 459 students preparing their theses, 390 fellows of other institutions, and 67 other young researchers to participate in its research activities in 1990.

The Institute for New Technologies, Energy and Environment

The Institute for New Technologies, Energy and Environment (ENEA) is involved in many educational activities. In 1990/91, 400 students were preparing their theses inside the ENEA's main research centres. These students received scientific and technical as well as logistical support (*e.g.* use of general services, the cafeteria, the transport system); L 400 million were budgeted in 1991 for this activity. Most of these theses are in the fields of physics and engineering, but non-negligible shares are in different disciplines.

ENEA also awards a number of fellowships for young researchers (67 in 1991); the fellows can choose their specific field of activity among the general goals of the institution and are followed by a designated tutor. As far as the doctorate is concerned, ENEA has financed, since the third cycle in 1986, a total of 135 candidates, for an average amount of L13 million per student, 6.5 million for a study period in a foreign country, and a variable contribution for the university organising the programme. The decision process is initiated by the university, which proposes the broad subject and training activities of the programme; ENEA then decides if it is interested in financing positions related to its specific scientific and research interests. The doctoral students are attached to a university but can spend a period in an ENEA laboratory and abroad. In this way, the institution promotes fields of study relevant to its activities and prepares young researchers to be introduced into the organisation. Table 4.11 sums up the breakdown by discipline of the doctoral students funded by ENEA since 1986.

Finally, ENEA supports a number of high-level courses and schools of specialisation; this activity, funded for an average of about L 230 million per year in the past years,

Table 4.11. **Doctorate positions funded by the Institute for New Technologies, Energy and Environment since 1986**

	Number of positions
Environment and health	26
Chemistry	25
Energy	24
Biology	18
Agriculture	13
Physics	12
Industrial innovation	13
Other	14
Total	135

Source: Institute for New Technologies, Energy and Environment, 1992

received a lower budget (L 120 million) in 1991 because of general restrictions in ENEA funding.

The national research programme and related research training

Another research training path is linked to the national research programmes. Since 1982, these programmes have covered strategic fields such as advanced biotechnology, new materials, and pharmaceuticals. In 1988, the government decided that 10 per cent of the total amount of funds for a national research programme must be spent for research training. The training activities linked to a research programme are structured so as to provide high-level scientific training, obtained mainly through "learning by doing", but also a considerable amount of research management training, including planning, strategic management, and evaluation and organisation of research projects.

The amount invested in training is rather high, considering that several billion lire are spent in funding the research activity (Table 4.12). For example, during the four years of activity of the National Programme for Pharmaceuticals, nearly L 6.5 billion (which was half of the sum devoted to research training, *i.e.* L 13 billion, out of a total amount of L 72 billion for the Programme) were spent to train 568 young researchers (GESCO, 1991; Casciato, 1991). Participants were trained in the universities, public or private research institutions, and firms involved in the programme, for an average period of 12 to 18 months; a professional co-operation contract with the firm or institute and a salary comparable to those they have received for other forms of research training (roughly L 1 million to 1.5 million per month). Other research programmes have engaged in the same kind of activity to a greater or lesser degree; the most recently financed programmes

Table 4.12. **Funding of national research programmes, 1990**
(billion lire)

Programme	Total funding
Microelectronics	158.2
Biomedical technology	29.3
Steel	80.5
Chemistry	230.1
Building	34.7
Oncology (technology for)	44.7
Pharmaceuticals	72.7
Advanced biotechnology	189.7
Heart surgery (technology for)	42.9
Bioelectronics (technology for)	99.7
Advanced materials	218.0
Environment	n.a.

n.a. Not available
Source: Ministry of Universities and Research

(advanced biotechnology, new materials, and chemistry) have proposed a full training programme. The goal of the advanced biotechnology programme, for instance, is to introduce into the labour market in five years' time a group of highly trained researchers to meet the growing demand (estimated at 400 researchers per year). The training programme will run for 30 months and will include lessons, seminars, workshop activities specifically organised for the programme, and study periods to be spent in universities and scientific institutions in Italy or abroad.

Conclusions

The difficulties encountered by universities in implementing the *dottorato di ricerca* in the 1980s led to a number of changes in the programme as initially conceived. These changes were aimed at a better fit between programmes and demand, both in quantitative and in qualitative terms. They were essentially designed to make procedures easier and more rapid by eliminating a number of bureaucratic steps and to meet students' requirements for recognition of their present and future role in the university and in research. The latter problem is still being studied; it is complex, involving as it does both the social and scientific role of the doctorate.

The situation described here may change soon, since an act to reform PhD studies is under discussion in the Italian Parliament. A number of substantial changes will take place if the act is passed in its present form. The main difference concerns autonomy and the decentralisation of doctoral studies. As mentioned above, the present structure is very centralised in many respects, such as number and type of posts, final defence of the thesis (with a Commission appointed at national level), and the awarding of the title. The proposed act would make individual universities responsible in all these respects. The Ministry of Universities and Research would still, however, authorise universities to organise doctoral programmes. Of course, the greater the autonomy, the more stringent the evaluation and control mechanisms should be.

Although the universities are now the primary source of training for research, through doctoral programmes, a number of different channels also offer possibilities for acquiring the experience and knowledge necessary for research work. The individual fellowships scheme for young graduates offers the most important means of working and studying in a research environment. All Italian scientific institutions have such schemes; they allow successful applicants to be associated with an institute of the National Research Council or a unit of the National Institute for Nuclear Physics, for example, for a period of one and sometimes two years and to carry out a research and study programme under the supervision of a scientist working full time in the institution. This relatively common practice allows graduates to acquire experience in a research project and thus to work and study at the same time. Generally speaking, this is considered as full-time work, and the salary is comparable to that offered for participants in doctoral programmes. At the end of the period, no formal title is awarded, but the experience acquired is a good reference for any future job in the field. It is quite a common practice to choose future researchers from the pool of fellows in such institutions.

The organisation of research training in Italy presents a rather diversified panorama. It should be noted that many, if not all, changes in the structure of research, education and training, particularly in the university sector, have to resist strong inertia. Very often, new initiatives or structures do not replace the old ones but are simply added on. This need not be completely negative, provided that the overall development is carefully planned, carried out, and monitored and is not simply the result of a series of compromises.

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Chapter 5

RESEARCH TRAINING IN JAPAN

by

Shinichi Yamamoto
University of Tsukuba

The structure of degrees and the current scale of research training

The Japanese higher education system and the structure of degrees

The Japanese higher education system consists of three types of institutions: universities, junior colleges, and colleges of technology. Although these three types of institutions have different missions, each has played an important role in providing people with higher education opportunities and has contributed to the expansion and popularisation of higher education today. In 1992, there were 523 universities, 591 junior colleges, and 62 colleges of technology. Enrolments were 2 293 000 at universities (including graduate schools), 525 000 at junior colleges, and 55 000 at colleges of technology. Out of Japan's 18-year-old population of 2 million, about 40 per cent advance to higher education.

While providing people with educational opportunities, the higher education system in Japan has also served as the key centre for scientific research. Universities have played the most important role in this area, serving as places of research training through graduate education or other kinds of training. From their founding in the late 19th century, universities were the only institutions that could grant research degrees until, in 1991, the government established the National Institution for Academic Degrees, whose mission is to award degrees to those who, having independently attained an equivalent level of higher education, are regarded as equal to graduates from a university or a graduate school.

Graduate schools and research degrees have seen several important reforms since the mid-1970s. One of the most important concerned the aim of graduate school courses. Before the 1970s, the purpose of graduate schools was thought to be limited to the training of future academic researchers. In 1974, responding to social and economic changes and to the growing demand for master's degrees, training of highly-qualified professionals was added to the objectives of master's degree programmes. Then, in 1990,

the aim of doctoral degree programmes came to include the training of people with high-level abilities and profound knowledge who are capable of working in various sectors of society, as well as the training of researchers to be employed at universities and other places.

The second important reform was the introduction of flexibility in the amount of time required for obtaining degrees. Prior to reform, a master's degree required two years of course work after completion of an undergraduate programme, and a doctor's degree required three years after obtaining a master's degree. Flexibility was first introduced into the requirements for the doctorate. Since 1978, a doctor's degree can be obtained, in exceptional cases, in just three years after graduation from an undergraduate programme. However, the doctor's degree is still generally granted five years after the bachelor's degree and three years after the master's degree. In 1989, the duration of the master's degree programme became flexible, so that, depending on their level of academic performance, students may complete the course in as little as one year.

The third type of reform had to do with the degree structure. The bachelor's degree was included among academic degrees in the 1991 reform. At the same time, the terminology of master's and doctoral degrees was simplified by the Academic Degree Order of the Minister of Education, Science and Culture. Thus, instead of doctor of economics, doctor of engineering, doctor of medicine, and so on, all doctorates are simply "doctor." Each university now identifies the area of science, *e.g.* PhD in physics, when it grants a degree.

Today, there are bachelor's, master's, and doctoral degrees. A bachelor's degree corresponds to graduation from an undergraduate programme, and a master's degree corresponds to the completion of a master's degree programme of a graduate school. A doctoral degree, however, in spite of the reforms, does not exactly correspond to the completion of a graduate school programme. In the social sciences and the humanities, many students still leave their graduate programmes without being awarded a doctorate. Japan has both a "course doctorate", which indicates that students have completed the course work for the degree, and a "thesis doctorate", which is independent of course work and is awarded for academic research. Thus, students continue their research outside or inside universities and submit theses several years or more after the end of their course work. They then obtain the degree.

The scale of research training

There are various modes of research training in Japan: formal or non-formal, within or outside the university, as students or as employees, and so on. Among these, the formal programmes of graduate schools play a key role in the training of future researchers for both universities and industry.

The scale of research training at graduate schools is reflected in graduate school enrolments. In 1991, 320 out of the total of 514 universities had a graduate school. Table 5.1 shows enrolments in the higher education system in Japan. Graduate school enrolments have been constantly increasing, but are still very small compared with undergraduate enrolments and enrolments in junior colleges. Overall, there were, in 1991,

Table 5.1. **Higher education enrolments in Japan**

	1989		1990		1991	
	Number	%	Number	%	Number	%
Colleges of technology	51 966	2.1	52 930	2.0	53 698	2.0
Junior colleges	455 696	18.1	473 194	18.2	497 559	18.4
Universities						
Undergraduate	1 929 137	76.5	1 988 572	76.3	2 052 335	75.9
Master's programme	58 228	2.3	61 884	2.4	68 739	2.5
Doctoral programme	27 035	1.1	28 354	1.1	29 911	1.1
Total	2 522 062	100.0	2 604 934	100.0	2 702 242	100.0

Source: Ministry of Education, Science and Culture. Basic School Survey

about 70 000 students enrolled in master's degree programmes and about 30 000 students enrolled in doctoral programmes. Graduate students, both master's and doctoral degree students, accounted for only 3.6 per cent of the total population in the higher education system, and graduate student enrolments were only 4.8 per cent of undergraduate enrolments. Corresponding figures were 15.6 per cent in the United States in 1987, 33.5 per cent in the United Kingdom in 1987, and 20.7 per cent in France in 1988. Such figures are sometimes used to argue that Japan should expand graduate school education.

Table 5.2 shows the first destination of new graduates from undergradúate and graduate education in 1991. Of 428 000 undergraduates, 7 per cent continue their studies at graduate schools, while of 27 000 master's degree recipients, 16 per cent go on to doctoral programmes.

The number of master's degrees and doctorates awarded each year is also a good indication of the scale of research training. In 1989, as is shown in Table 5.3, 26 047 master's degrees and 10 036 doctorates were awarded. About half of the master's

Table 5.2. **First destination of new graduates, 1991**

	More advanced study		Employment		Unemployment		Unknown and other		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Undergraduate	30 005	7.0	347 885	81.3	25 603	6.0	24 586	5.7	428 079	100.0
Master's programme	4 310	16.1	19 504	72.7	1 888	7.0	1 113	4.2	26 815	100.0
Doctoral programme	20	0.3	4 113	66.3	1 408	22.7	660	10.6	6 201	100.0

Source: Ministry of Education, Science and Culture. Basic School Survey

Table 5.3. **Research degrees awarded by field of study**

	1985		1986		1987		1988		1989		1989[1]	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Master's degree												
Humanities	2 090	9.8	2 156	9.6	2 253	9.4	2 261	8.9	2 226	8.5		
Social sciences	1 612	7.6	1 701	7.6	1 798	7.5	1 942	7.6	2 123	8.2		
Science	2 133	10.0	2 261	10.1	2 508	10.4	2 692	10.5	2 895	11.1		
Engineering	9 612	45.2	10 390	46.5	11 092	46.1	11 913	46.7	12 740	48.9		
Agriculture	2 336	11.0	2 305	10.3	2 501	10.4	2 725	10.7	1 807	6.9		
Health	997	4.6	1 002	4.5	1 058	4.4	1 126	4.4	1 175	4.5		
Education	1 517	7.1	1 573	7.0	1 747	7.3	1 777	7.0	1 871	7.2		
Other	993	4.7	966	4.3	1 096	4.6	1 088	4.3	1 210	4.6		
Total	21 270	100.0	22 354	100.0	24 053	100.0	25 524	100.0	26 047	100.0		
Doctorate												
Humanities	86	1.1	91	1.1	102	1.1	98	1.0	95	0.9	83	1.5
Social sciences	127	1.6	136	1.6	149	1.6	167	1.7	177	1.8	125	2.2
Science	860	10.8	820	9.6	837	9.1	881	9.2	876	8.7	345	6.1
Engineering	1 404	17.6	1 493	17.5	1 547	16.9	1 717	17.9	1 774	17.7	982	17.3
Agriculture	697	8.7	646	7.6	715	7.8	746	7.8	734	7.3	430	7.6
Health	4 727	59.3	5 233	61.3	5 657	61.8	5 789	60.3	6 084	60.6	3 617	63.6
Education	23	0.3	33	0.4	41	0.4	36	0.4	40	0.4	28	0.5
Other	54	0.7	81	0.9	109	1.2	168	1.7	256	2.6	77	1.4
Total	7 978	100.0	8 533	100.0	9 157	100.0	9 602	100.0	10 036	100.0	5 687	100.0

1. Number of thesis doctorates included in the figures.

Source: Ministry of Education, Science and Culture.

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degrees were in engineering, reflecting the recent popularisation of master's degree training in engineering fields, and the second largest percentage was in science. For doctorates, 60 per cent were in medicine or related fields. If the shares of master's degrees and doctorates in various fields are compared, there is a smaller percentage of doctorates in the humanities and the social sciences. This does not mean that enrolments in these disciplines are low to the same degree. Table 5.4 suggests that many students in these fields complete the doctoral course work without obtaining degrees.

Besides these features, the effects of the "thesis doctorate" should be mentioned. Of 10 036 doctor's degrees awarded in 1991, 57 per cent or 5 687 were in this category. In the humanities, most of the degrees awarded were thesis doctorates, and even in engineering, more than half were thesis doctorates.

After formal graduate education has been completed, students have several ways to continue research training. One is to be employed as an assistant at a university or college. There were 34 175 full-time assistants in the university sector in 1991. Some work for university hospitals, and others carry out research or receive research training while helping in the work of their professors (there were 45 631 full professors in Japan in 1991). Assistantships have offered the typical career path for young researchers wishing to work in the university sector. The assistant is the lowest rank, but it is the first step in a tenure-track faculty position. In 1991, there were 474 master's degree graduates and 1 535 doctor's degree graduates (Table 5.4), with or without degrees, employed by universities after finishing their course work.

While graduate students may take a positive view towards employment as a full-time assistant, such positions are somewhat limited. An alternative is to become a postgraduate researcher and continue research or research training within or outside the university system. There are about 500 postdoctoral researchers funded by a special fellowship programme of the Japan Society for the Promotion of Science (JSPS). With more than 1 300 applicants for the fellowship programme in 1992, and in light of the results of an informal survey, there are estimated to be several thousand postgraduate researchers in Japan. Some of the unemployed new graduates from doctoral programmes (1 403 in 1991, as shown in Table 5.2) might be included among postdoctoral researchers.

A third choice is to work in industry as a researcher or other type of professional. In 1991, 1 134 master's degree graduates and 394 doctoral degree graduates entered employment as scientific researchers in government or corporate laboratories. Besides these, many other students, especially in science and engineering, prefer going to industry to remaining in university labs. Some of them later write theses and submit them to the universities from which they graduated. From this point of view, young researchers employed at government or corporate laboratories might be also counted as research trainees.

Table 5.4. **New graduates entering employment, 1991**

	University teacher		Researcher		Other professional		Other		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Master's degree										
Humanities	58	10.1	6	1.0	318	55.5	191	33.3	19 504	100.0
Social sciences	47	4.1	11	1.0	222	19.4	865	75.5	573	100.0
Science	26	1.4	180	9.7	1 510	81.6	134	7.2	1 145	100.0
Engineering	137	1.2	339	2.9	10 532	90.5	625	5.4	1 850	100.0
Agriculture	19	1.5	285	22.9	834	67.1	105	8.4	11 633	100.0
Health	47	4.5	297	28.6	680	65.5	14	1.3	1 243	100.0
Education	71	4.9	9	0.6	1 191	81.8	185	12.7	1 038	100.0
Other	69	12.2	7	1.2	356	62.9	134	23.7	1 456	100.0
Total	474	2.4	1 134	5.8	15 643	80.2	2 253	11.6	38 442	100.0
Doctorate										
Humanities	218	75.2	11	3.8	46	15.9	15	5.2	290	100.0
Social sciences	214	82.0	13	5.0	15	5.7	19	7.3	261	100.0
Science	129	37.2	101	29.1	106	30.5	11	3.2	347	100.0
Engineering	298	39.7	77	10.3	313	41.7	62	8.3	750	100.0
Agriculture	97	39.8	90	36.9	47	19.3	10	4.1	244	100.0
Health	565	26.6	98	4.6	1 448	68.1	14	0.7	2 125	100.0
Education	47	81.0	0	0.0	6	10.3	5	8.6	58	100.0
Other	17	44.7	4	10.5	13	34.2	4	10.5	38	100.0
Total	1 585	38.5	394	9.6	1 994	48.5	140	3.4	4 113	100.0

Source: Ministry of Education, Science and Culture, Basic School Survey.

The current organisation and content of research training

The role of the graduate school system for research training

Graduate schools carry out basic research activities in all academic disciplines and thus provide a sound basis for the development of scientific research in all fields. They are also responsible for the development of highly-qualified researchers and professionals. In terms of formal training, only the graduate school system trains researchers and professionals and awards them master's degrees and doctorates.

Although graduate schools are independent units within the university system, they are usually composed of several departments which correspond to those in the undergraduate programme and, for convenience, have been managed together with them for financial and other kinds of management. Recently, however, universities have begun establishing independent postgraduate divisions or programmes. Also, a new type of university consisting only of graduate schools has been established.

With regard to research training, the graduate school system plays several important roles. One is to provide students, through intensive formal education, with the basic knowledge and skills for carrying out research and development. According to government regulations, more than 30 credits of course work are generally required for the master's or doctoral degree. One credit corresponds to 45 hours of study.

The system's second role in research training is to offer opportunities to engage in research by involving students in research teams or research units headed by professors or associate professors. A research team or unit in a science or engineering field is composed of a professor and/or associate professor, assistant professor, assistant(s), technician(s), graduate students, and sometimes undergraduate seniors. In the case of the humanities and the social sciences, the unit is usually smaller. Graduate students are regarded as an essential part of the work force for research activities at university laboratories. This is a valuable way to train students and also, because of the limited number of assistants and technicians, graduate student involvement may be helpful to professors.

The system's third role is to award research degrees. With the exception of the National Institution for Academic Degrees, this function is the exclusive privilege of universities. Since a doctorate, especially in science and engineering, is regarded as a kind of licence for researchers and a master's degree as a kind of licence for professionals, training in graduate schools is essential for employment in universities and, in some cases, in industry. A doctorate does not, however, have this significance in the humanities and social sciences (except for economics). Many faculty members in these fields do not hold a doctorate.

Funding for research and training

Research funding in Japan is characterised by dual funding from a single funding source, the Ministry of Education, Science and Culture (Monbusho). First, funds are provided to national universities on the basis of the number of faculty members and cover

expenses for facilities, libraries, maintenance, and other university running costs, as well as direct research expenses for each faculty member (general university funds, GUF); these funds amounted to about ¥ 113 billion in the fiscal 1991 budget.

The second funding mechanism provides individual researchers or research groups with grants-in-aid for scientific research. Funding is granted on the basis of competitive applications from researchers belonging to universities and institutions of higher education. Grant applications are screened by the Science Council of Monbusho. The budget for such grants has continued to increase even under unfavourable financial circumstances, and the relevant budget for fiscal 1991 was ¥ 59 billion.

Besides these two funding mechanisms, research funds from industry have been increasing rapidly. In fiscal 1991, donations from industry to universities amounted to ¥ 43 billion.

Since the budget items for salary expenses and for research expenses are kept strictly separate, the funds mentioned above cannot be used for hiring and paying graduate students and postdoctoral researchers as research assistants or research associates. Japan does not so far have a system for funding graduate or postdoctoral research assistantships in the university sector. On the other hand, the Institute of Physical and Chemical Research (RIKEN), for example, which is outside the university system, pays ¥ 485 000 per month to a limited number of postdoctoral researchers (only 75 during 1989-91). Most funding for graduate students and postdoctoral researchers consists of fellowships and loans.

There are now several kinds of fellowships for graduate students and postdoctoral researchers in Japan. The largest programme is JSPS's Fellowship Programme for Young Japanese Researchers, established in 1985. This programme funds about 800 graduate students in doctoral degree courses and about 500 postdoctoral researchers. Each graduate student receives ¥ 156 000 (about $1 250) and each postdoctoral researcher ¥ 262 000 monthly. In addition to the stipend, they receive research funds of up to ¥ 1 500 000 a year. This fellowship programme is competitive. Loans and grants are also available for graduate students. About 32 000 graduate students received loans or grants from public and private organisations in 1987. Among these organisations, the Japan Scholarship Foundation is the largest. It provides loan scholarships to able students who have difficulty continuing their education for economic reasons. The Foundation assisted 17 210 master's degree students and 13 550 doctoral degree students in 1992; master's degree students received ¥ 75 000 and doctoral students ¥ 106 000 monthly.

Research degrees and the labour market

As shown in Tables 5.2 and 5.4, of the 26 815 new master's degree recipients in 1991, 19 504 entered employment, about 80 per cent of them in professional positions outside universities. About two-thirds of the professional jobs went to engineering degree recipients. This is partly a reflection of the popularity of master's degrees in engineering and of the need for engineering professionals. About 10 per cent of the graduates in the humanities found employment as university teachers (including assistants).

Of the 6 201 graduates from doctoral degree programmes (including, for technical reasons related to statistical data collection, those who were not awarded degrees), about 63 per cent entered employment. In the humanities, social sciences, and education, the majority became university teachers. In science and engineering, the majority found work outside universities (researcher, other professional, and other). This reflects differences of preferences among graduates as well as differences in demand by industry.

The relation of degrees to the labour market is very complex. Some find that too much value is placed on academic background and too little on real ability. This criticism gave rise to national discussion, and, as a result, the Prime Minister established the National Council on Educational Reform (1984-87). Others view graduate school education and holders of doctorates negatively, saying that the graduates are too academic, narrowly specialised, and unco-operative. Under Japan's employment system, students have their best chance to find employment when they graduate (often as undergraduates); the (undergraduate) university they graduate from is the critical factor. Under these circumstances, students going on to graduate school are considered adventurous unless their goal is an academic job. The increase in graduate enrolments in engineering, however, suggests an improvement in this situation.

Satisfaction and dissatisfaction – current problems

Underfunding of basic research and the declining attractiveness of doctoral degree programmes at graduate schools

Fighting a government budget deficit since 1983, the Ministry of Finance has maintained a policy of "minus ceiling", meaning that ministries, with very few exceptions, could not request more budget than they received in the previous year. Thus, allocations for universities have remained almost flat. The general research funds allocated to national universities (GUF), for example, grew only 8 per cent for each faculty member from 1980 to 1990, although the consumer price index rose 26 per cent during the same period. Although other budget items such as grants-in-aid for scientific research to university researchers (based on competition and granted on the basis of the quality of proposals) have increased more, each university researcher in 1990 had, on average, only ¥ 810 000 to purchase research equipment, while researchers at non-university research institutes averaged ¥ 4 290 000 and company researchers ¥ 3 110 000.

The budget for facilities at national universities and colleges dropped drastically from ¥ 151 billion in 1980 to 85 billion in 1990 and, inevitably, the amount of construction and repair decreased 60 per cent over the same period. About 40 per cent of the total floor area of the buildings of national institutions are 20 or more years old. The repair and reconstruction of these obsolete buildings are among the current major tasks of the government.

Under these circumstances, graduate schools have seemed to lose their attractiveness to students who want to be researchers. The number of doctoral students in science and engineering is reportedly decreasing at major universities. According to a

1990 Monbusho survey, the main reason given by those who completed a master's course for taking a job instead of proceeding to a doctorate was "in accordance with original plan", followed by "due to financial situation" (see Table 5.5). These reasons can be stated in another way. As shown in Table 5.6, nearly 60 per cent of young researchers answered that the reason for taking a job in private companies was that "private companies offer higher salaries". The second most important reason was "private companies have better research conditions". With Japanese students decreasing in number, students from foreign countries, mainly from Asian countries, have been increasing, and helping to sustain the doctoral degree programmes.

It has become an important task to develop excellent and creative young researchers in various fields, so that Japan's scientific research activities may develop further in response to the demand for large-scale and more advanced research projects and for creative and pioneering research activities that contribute to world scientific research. In July 1992, the Science Council, an advisory body to the Minister of Education, Science and Culture, submitted to the Minister a recommendation that the fellowship programme for young Japanese researchers be improved.

Table 5.5. **Reasons given by those who completed a master's course for taking a job rather than pursuing a doctorate**

	Percentage
In accordance with original plan	66.9
Due to financial situation	40.4
Considering vocational aptitude	30.9
Interested in developmental research at private companies	29.4
No aptitude for scientific research	24.3
Shortage of teaching posts at universities	21.3

Source: Survey by Ministry of Education, Science and Culture, 1990 (multiple answers).

Table 5.6. **Reasons given by young researchers for taking a job in private companies**

	Percentage
Private companies offer higher salaries	58.6
Private companies have better research conditions	46.1
University teaching posts are limited	36.5
University administration system is not agreeable	27.0
Human relations at university are not good	14.4
Significant research is possible at private companies	7.1
Private companies have many excellent researchers	3.9

Source: Survey by the Ministry of Education, Science and Culture, 1990 (multiple answers).

Demands for structural changes to the research system

Although there is strong support, not only in academic circles but also in industry, for improving research environments at universities, there are also growing demands that universities should respond to current academic and social needs and reform their system of research. Universities have been criticised with respect to: the equal distribution of resources among faculty members (which makes it difficult for able researchers or research groups to expand their research); life-long employment and the chair system (which prevent able researchers from obtaining early promotion or from moving to other universities or research institutes); and insufficient response to social changes or social needs in some social science research activities (which dissuades people outside the universities from offering support).

In its recommendations of July 1992, the Science Council pointed out certain problems in the academic research system, *i.e.* lack of flexibility in the structure and management of research, poor response to academic or social demands, and a worsening research environment. The Council recommended that, while it was the government's responsibility to maintain the research infrastructure and improve the research system and its management, each institution should also make efforts to stimulate its research system through mobility of researchers, an evaluation system, etc. Thus, the Council proposed the expansion of joint research systems, the establishment of expanded research units and visiting professorships, the participation of researchers from different research systems in research projects for fixed periods, and joint use of facilities by several universities. It also recommended priority setting for the expansion of research systems, the formation of research networks, and the creation of "centres of excellence".

Needs for expansion and strengthening of graduate schools

The Science Council, the University Council, and others have called for the expansion and strengthening of graduate schools. In 1992, the Science Council supported the University Council's 1991 recommendation that, by the year 2000, Japan should have at least twice as many graduate students as at present, including adult students and students from foreign countries. According to the University Council or related councils, the main reasons for increasing graduate school enrolments are to: *i)* keep up with the advancement and sophistication of academic research; *ii)* train an adequate number of promising researchers; *iii)* prepare highly qualified professional workers in various fields; and *iv)* make an international contribution through research and education. As mentioned above, the scale of graduate education in Japan is still very small by international standards. Although the situation varies among research fields, one of the most important issues has been whether or to what extent graduate school education and research training should be expanded.

In its 1991 recommendation, the University Council considered several factors in estimating the demand for graduate education. The first was the fact that graduate enrolments had been expanding for the past ten years: by 180 per cent for master's degree courses and 160 per cent for doctoral degree courses. The second was that there will be a growing demand for highly-qualified professionals in industry and also a certain demand

for researchers at non-university institutions. The third factor was the rapidly increasing demand for "continuing education" for adults, which will further increase if graduate education is expanded. The fourth was the trend toward increasing numbers of foreign students, in line with the government's scheme to accept 100 000 foreign students at universities by the year 2000. Due to the recent uncertainties of social and economic change, estimates of the demand for graduates of master's and doctoral programmes will also be uncertain to some extent. Training researchers and professionals, however, will be more important in the future. The Science Council, in its recommendation of 1992, referred to the necessity of new long-range estimates of the demand and supply of researchers. A research project on this matter, funded by Monbusho, has just started and will be completed within a year or so.

New initiatives

Expanding financial aid for young researchers

There are various new fellowship and other programmes for graduate students and young postdoctoral researchers, which are founded on the notion that the training and securing of researchers is most important for strengthening the basis of scientific research and for its further development. Among these programmes, the fellowship programme for young researchers sponsored by JSPS, known as the Fellowship Programme for Young Japanese Researchers, which was established in 1985, is the largest.

The aim of the JSPS programme is to provide talented young researchers, at both the doctoral and postdoctoral level, with opportunities to devote themselves to scientific research freely during the early stages of their research life, and to choose research subjects and research sites independently. This programme has grown from 144 researchers in 1985 to 1 300 in 1992, and, according to Monbusho, it is highly valued by universities and other institutions of scientific research as a good system for training and securing young researchers who will sustain scientific research in Japan.

There are also more mission-oriented programmes for young researchers which are sponsored by governmental agencies other than Monbusho. One example is the already mentioned programme established in 1989 at the Institute of Physical and Chemical Research (RIKEN) and sponsored by the Science and Technology Agency (STA).

The shift from general to specific research funding

In response to the underfunding of research at universities, Monbusho has made efforts to increase funds and to maintain the research infrastructure for academic research. However, in contrast to traditional funding policies, the new trend is to shift from general funding on the basis of a standard formula to specific funding based on competition.

In terms of basic research funds, the amount of grants-in-aid for scientific research increased 70 per cent from 1982 to 1992, while general university funds (GUF) increased only 30 per cent overall and remained almost flat on a per research unit basis. While research funds from private sources have increased more (nearly 500 per cent), these are usually targeted for specific purposes. In some research-oriented universities, however, it is reported that they receive as much in grants-in-aid and private funds as from GUF.

Budgets for the training and securing of researchers have increased more for competitive programmes like the JSPS fellowship programme than for general programmes which provide loan scholarships to students on the basis of financial need. In the fiscal 1992 budget, teaching assistantships were introduced for the first time to help graduate students continue their research without economic difficulties and to improve quality in graduate schools. This system is also competitive.

Strengthening graduate schools

Monbusho has taken a series of important measures to strengthen graduate schools, including measures for the flexible management of the graduate school system. As a result, graduate schools based on new concepts have been established and existing schools have been improved. As already mentioned, some new graduate schools are separate from undergraduate establishments, both financially and in terms of personnel.

As for measures for the flexible management of the system, Monbusho has invested significant amounts of money to strengthen graduate schools and introduced a special budget item for improving graduate schools in fiscal 1992, with ¥ 4 billion to be distributed to selected national graduate schools that demonstrate excellent performance in research and education.

Recent policies related to higher education and academic research have focused on improving graduate schools rather than undergraduate programmes, on a selective basis. Although this does not necessarily mean the creation of "research universities" in Japan, there is a tendency towards allocating resources on the basis of established priorities. The Science Council also supports the promotion of scientific research on the basis of such priorities.

Conclusions

In today's world of rapid technological change and the spread of information media, it has become important for all countries of the international community to promote creative basic research of high standards and to train those who will contribute to such research. In this regard, monitoring and assessing the research training system has become increasingly important for both the government and individual universities.

Although the graduate school system is now expected to play the key role in training researchers and professionals, this has not always been the case. In the 1970s and early 1980s, Japan had an oversupply of young researchers, although there was less graduate school education than there is today. At that time, it was said that graduate schools should

respond to social needs and train more professional workers instead of training so many highly-specialised university researchers. In the late 1980s and in the 1990s, however, active investment in research and development by private companies has resulted in a shortage of young researchers for basic research. In the mid-1990s and beyond, there will be a strong demand for well-qualified researchers for basic research, despite the projected decline of the 18-year-old population.

If there is to be a proper response to these social and economic changes, it is necessary for policy-makers to understand the structure of the labour market for researchers and professionals and the role of research training systems at graduate schools and elsewhere. Intensive studies in co-operation with the academic community are strongly needed.

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Chapter 6

POSTGRADUATE RESEARCH TRAINING IN THE UNITED KINGDOM

by

Robert G. Burgess, John V. Hogan, Christopher J. Pole and Lee Sanders
Centre for Education Development, Appraisal and Research (CEDAR)
University of Warwick, England

The last decade has witnessed several significant changes to the structure and culture of postgraduate research training in the United Kingdom. This has resulted in important changes to the traditional apprenticeship model: a single research student working under the guidance of an eminent university scholar. Research councils, learned societies, higher education institutions and, most of all, government departments, spurred on by a desire to achieve value for money on the investment in research training, have been concerned to make research training more systematic, by improving completion rates, reducing drop-out rates, providing formalised training programmes, and so on.

The development of postgraduate research training

Postgraduate research training developed relatively slowly in the United Kingdom when compared to Germany and the United States. While the University of London awarded earned master's degrees from its foundation in 1836, the two premier universities, Oxford and Cambridge, did not award any degrees for postgraduate work during the 19th century. These universities did, however, award higher doctorates (DSc, DLitt, DPhil) for substantial research work undertaken over a long period. The PhD was imported from the United States, and it was only in 1917 that the University of Oxford first introduced the lower doctorate into Britain, largely to attract American scholars away from Britain's then war-time enemy Germany (Simpson, 1983). The PhD was designed to be completed after two or three years of research, but this new degree was not rapidly integrated into the UK higher education system. In 1938, there were only 3 000 postgraduates, or 6 per cent of the full-time total student population, in UK universities. The

number of postgraduates increased rapidly in the 1960s; more state studentships were provided to help increase the number of trained experts required to take up academic posts in the rapidly-expanding higher education sector (Rudd, 1975, pp. 15-21).

Despite the increasing number of research students, British universities, unlike their American counterparts, did not adopt a separate organisation for administering postgraduate research training, and research training is still all too often a poor third to undergraduate teaching and research work in terms of institutional priorities.

The undergraduate bachelor's degree is normally awarded after three years of full-time study, and a number of these degrees include provision for an intercalated year spent in industry or abroad (to improve foreign language skills). The British first degree is a specialised qualification, with students normally studying one discipline in depth, although there is an increasing emphasis on interdisciplinary teaching. Traditionally, the British first degree involves lectures, small group seminars or tutorials, and practical laboratory work for the sciences. The increase in student numbers has led to larger classes, with the result that university staff are making more use of innovative teaching techniques: syndicate methods, video, and interactive computing.

The pattern of undergraduate study is such that students are encouraged to reach their own conclusions and question accepted authorities. Many students have the opportunity to develop a special project in some depth in their final year; this may include some original work in dissertations and special subject options. However, training in advanced research techniques or opportunities to carry out original research work are not major elements of the undergraduate degree syllabus. The bachelor's degree is a reasonable, but not sufficient, preparation for postgraduate research training. Unlike the German or Italian first degree, there is no provision for conducting a substantial original project. This preparation is normally part of a taught (course work) master's degree.

The current dimensions of postgraduate research training

No comprehensive statistical information exists on the present size of the student population engaged in postgraduate research training in UK universities. The statistics that follow relate to the 50 universities in Great Britain that received funding from the Universities Funding Council (UFC), together with corresponding data for the two universities in Northern Ireland, in 1990/91 (UFC, 1987-92). Only estimated figures are available for the number of research students enrolled in the "public sector" institutions led by the 30 polytechnics. The end of the "binary divide" between universities and polytechnics in 1992 and the establishment of the Higher Education Funding Councils should mean that more systematic information will be available on postgraduate research student numbers, as this is essential for planning.

Numbers of postgraduate research students

In 1990/91, there were 45 757 postgraduates in UK universities, of whom 28 777 (63 per cent) were full-time and 16 980 (37 per cent) part-time students. The total number

Table 6.1 **Postgraduate research students in UK universities, 1986/87 to 1990/91**

(thousands)

	1986/87	1987/88	1988/89	1989/90	1990/91	Percentage change since 1989/90
Research students	42.0	43.0	43.9	44.3	45.7	3.2
Total postgraduates	91.2	92.2	98.2	103.9	112.1	7.8
Research students as a percentage of all postgraduates	46.1	46.6	44.7	42.6	40.8	-1.8
Total students	360.8	366.9	383.6	404.8	428.8	5.9
Research students as a percentage of total students	11.6	11.7	11.4	10.9	10.7	-0.2

Source: Universities Funding Council: *University Statistics, Vol. 1: Universities Statistical Record*, various years.

of postgraduate research students had increased (3 730 or 9 per cent) since 1986/87, compared with a 27 per cent increase in the total numbers of postgraduates enrolled for taught programmes (master's degrees, postgraduate diplomas, and certificates) over the same period. The larger increase in taught postgraduates means that the number of research students, as a share of the total number of postgraduates, has decreased by 5.3 per cent since 1986/87. The number of research students as a proportion of all students in UK universities has also declined slightly since 1986/87 (down 0.9 per cent) (Table 6.1).

The largest concentration of research students in 1990/91 was at Oxford and Cambridge (14 per cent of all postgraduate research students), and 30 per cent of all humanities research students were enrolled at Oxford and Cambridge in 1990/91 – the largest proportion of any subject group in UK universities.

The number of research students in "public sector" institutions was estimated at 4 190 in 1987/88 , of whom 2 640 were full-time and 1 550 part-time (Henkel and Kogan, 1993, p. 91). In all, 47 267 postgraduates were engaged in research training in the United Kingdom in 1987/88 . Although only 9 per cent of postgraduate training was in the "public sector", this is a significant proportion, given that the original role of the polytechnic sector was to concentrate on applied research and development rather than to advance fundamental and theoretical research and scholarship and the application of the results (Henkel and Kogan, 1993, pp. 18-20).

Number of doctorates awarded

In 1990, 8 188 doctorates were obtained from UK universities, an increase of 26 per cent from 1986. The largest numerical increases in PhDs awarded between 1989 and

Table 6.2. **Total doctorates awarded in UK universities, 1986-90**

	1986	1987	1988	1989	1990	Percentage change since 1989
Total doctorates awarded	6 942	6 835	7 588	7 801	8 188	4.9

Source: Universities Funding Council: *University Statistics, Vol. 1, Universities Statistical Record*, various years.

Table 6.3. **Doctorates awarded in UK universities, by subject, 1989 and 1990**

	1989	1990	Percentage change
Medicine and dentistry	437	456	4.3
Studies allied to medicine	352	330	-6.2
Biological sciences	1 154	1 276	10.5
Veterinary science, agriculture and related sciences	229	228	-0.4
Physical sciences	1 625	1 659	2
Mathematical sciences	407	465	14.2
Engineering and technology	1 282	1 463	14.1
Architecture and related sciences	63	69	9.5
Social sciences	732	683	-6.6
Business and financial studies	153	150	-1.9
Librarianship and information sciences	29	28	-3.5
Languages and related studies	387	426	10
Humanities	463	464	0.2
Creative arts	54	42	-22
Education	208	207	-0.4
Multi-disciplinary studies	70	63	-10

Source: Universities Funding Council: *University Statistics, Vol. 1, Universities Statistical Record*, 1989/90, 1990/91.

1990 were in engineering and technology (up by 181, or 14 per cent) and biological sciences (up by 122, or 11 per cent). No estimate is available for the number of research degrees awarded by "public sector" institutions (Tables 6.2 and 6.3).

The structure of postgraduate research training

With the recent abolition of the separation of universities and polytechnics, and the redesignation of polytechnics as universities, 96 universities are now responsible for the vast majority of postgraduate training. Some agencies outside the university sector also contribute to postgraduate research training, including research laboratories and private sector companies, but, in virtually all cases, they do so in close collaboration with the universities, which have primary responsibility for research training standards.

Under the traditional model, postgraduate research students who have just completed their first degree work under the guidance of an eminent university scholar. While this model has changed in important ways, it still forms the basis of most postgraduate research training and serves to socialise students into a discipline.

Most postgraduate students register for the PhD, which normally requires three years of full-time study. Some students register with the intention of obtaining a master's degree – usually either an MA or MSc taken full-time in one year, or an MPhil taken full-time in two years. Normally, only students who achieve a first or upper second class honours in their undergraduate degree are admitted to a research degree, although exceptions are made for those with relevant professional experience. Nevertheless, the first or upper second class honours degree is essential for obtaining a research grant from a research council or the British Academy. Departments will not admit a student unless they are satisfied that they have a potential supervisor with the necessary expertise for the proposed research project. PhD students are expected to undertake a study that makes "an original contribution to knowledge". This entails the presentation of a thesis – usually 70 000 words or so in the arts and social sciences and slightly less in the sciences – and an oral examination.

Under the apprenticeship model, the personal relationship between the student and the supervisor shapes the nature of the training provided. Burgess *et al.* (1992) found that, at the beginning of postgraduate study in the social sciences, supervisors acted as project managers. However, their role shifted over time, with the result that they often eventually became critical friends offering guidance and support. Thus, the form and content of the guidance provided may vary considerably, even within the same academic department. The apprenticeship model has the advantage of being simple to operate, with clear lines of responsibility between the student and the supervisor, and between the supervisor and the university. The theses produced are made publicly available, and many are subsequently published in full as scholarly monographs or as a series of papers in learned journals.

A British PhD, unlike its American counterpart, is traditionally entirely based on research. It is an all or nothing approach: a thesis is submitted or it is not. If it is submitted, it usually is accepted, sometimes with revisions or corrections. Few students actually fail the examination process, although occasionally an MPhil is awarded for work submitted for the degree of PhD (Rudd, 1985, p. 37).

There are important differences in the traditional model in different disciplines, and the selection of the research topic is critical to the student's eventual success. In the natural sciences, a postgraduate joins a research team and works on a research thesis while contributing to the overall research effort of the group. In the humanities and social sciences, instead, students normally select their own topics and work independently (Rudd, 1975, p. 66). Formal contact with the supervisor is much greater in science departments. One survey of departmental supervisory practice found that students met with their supervisors at least once a week in 82 per cent of engineering departments, 91 per cent of physical science departments, and 79 per cent of biological science departments, but only in 35 per cent of social science departments (Advisory Board for the Research Councils, 1982, p. 27).

Some problems with the traditional model

Many of the changes to the traditional apprenticeship model have been inspired by the American system, which places more emphasis on taught courses as a means of introducing substantial elements of training over two or three years and in which teams of academics may act as advisors for PhD projects. Some of these practices have recently appeared in the United Kingdom, as moves have been made to incorporate taught elements into the PhD (especially in the social sciences). These courses are designed to broaden students' perceptions of their disciplines, but also to teach the research skills necessary to complete a research thesis.

More students are now encouraged to complete a taught master's degree before proceeding to a research degree. Since the publication of the Advisory Board for the Research Councils' (ABRC) report on postgraduate education in 1982, two issues have dominated debate about research training: the length of time the training should take and the elements of research training to be incorporated into a traditional PhD. The ABRC report was critical of the length of time it took students to complete their work and recommended that full-time PhD students should complete within four years, with the investigation being completed in three years and the writing in the fourth year. The report criticised the traditional PhD for being overly-ambitious and urged that topics should be defined so that completion within a four-year period was feasible. The report identified three main reasons for poor completion rates: poor supervision, especially in the early stages; lack of adequate knowledge of research techniques; and low student motivation. The problem of poor submission rates has been particularly serious in the humanities, where about half the students supported by the British Academy who started their PhDs in 1984 had not submitted within six years (*The Times Higher Education Supplement*, 1991).

Most PhD students who are fortunate enough to receive financial support from one of the research councils [the Economic and Social Research Council (ESRC) for the social sciences, the Science and Engineering Research Council (SERC), the Agricultural and Food Research Council (AFRC), the Medical Research Council (MRC) and the Natural Environment Research Council (NERC) for the natural sciences, or the British Academy for the humanities] receive a grant for three years. However, as the ABRC report acknowledged, comparatively few students are able to submit their final thesis during this period. Thus, they normally enter a one-year extension or continuation period during which they are expected to complete the writing of the thesis. However, access to their supervisor, work space, and other facilities, including the library, is typically reduced, and in some institutions, access to a supervisor may be formally reduced, thus delaying even further the submission of the final thesis.

Since the publication of the ABRC report, the research councils have introduced a sanctions policy to improve national submission rates by disqualifying departments or universities with a low number of students submitting a thesis within four years of receiving research studentships. Currently, those social science departments where less than 50 per cent of ESRC-sponsored students submit a thesis within four years will be blacklisted for two years. However, in 1993, no department was in this position, as social

science submissions have improved over the last seven years, because universities have been selective about departments allowed to take postgraduates.

There are a number of reasons for the attention given to submission rates. Concern has been expressed about the large amount of government funding used to support research students for three years of full-time study when the return on this investment, in terms of completed PhDs, was slow in coming. It was also recognised that, in an environment of limited job opportunities in higher education, it was in the students' best interest to complete as quickly as possible, rather than continue to perfect the thesis while clinging to the hope of eventually securing an academic post. The longer the work took, the more likely it was that the student would tire of the thesis, that his/her personal circumstances would change, or, particularly in the sciences, that the research data would be dated. In the United Kingdom, the drop-out rate for full-time undergraduates is low, and it is unusual for students to take longer than the minimum period required to complete a degree. It is thus easy to see why the issue of poor submission rates for postgraduate research students has caused such concern.

At the heart of the criticisms of the traditional PhD is the view that the training process should be emphasised. The Committee of Vice-Chancellors and Principals (CVCP) of UK universities, in its guide to the British PhD (1988), adopted the view that the PhD should be both a product, an original contribution to knowledge, and a process, the training of a researcher. The only way to accomplish this goal within four years is to define the thesis topic carefully and to accept the notion of a PhD programme with formal training elements complementing the original research work. Such a structure is regarded as a way of broadening the narrow traditional PhD while helping to improve the completion rates. Indeed, Burgess *et al.* (1992) found that training programmes in the first year of a social science PhD programme helped students to "tool up" on a range of research techniques that could be used in their projects. In addition, the formal socialisation process helped students to acquire academic values and to become incorporated into a discipline.

There are, however, criticisms of this approach. It is difficult to combine both the formal training elements and the research into a coherent package, and some students do not see the relevance of course work to their research topic (Hughes *et al.*, 1991). There have also been suggestions that the PhD thesis should be replaced by a series of research papers on a variety of topics linked to a central theme. Indeed, some departments of economics have encouraged students to present a thesis in the form of a series of papers that could be published in learned journals. Nevertheless, the idea of a single thesis making a substantial contribution to a discipline is a powerful concept which seems likely to remain dominant (Hughes *et al.*, 1991, p. 81; ABRC, 1982, pp. 60-61).

Among other problems that have been raised, there is the difficulty of selecting, with any degree of certainty, students who will be suitable for research. The available evidence suggests that the first degree result is not a reliable indicator of research performance (Hudson, 1977; Phillips *et al.*, 1987, p. 141). For many students, research is a lonely experience, and personal motivation, which is not always reflected in the first degree result, is essential to successfully completing research training (Rudd, 1975, pp. 86-106; Burgess *et al.*, 1992).

The relationship between supervisor and research student is vital to the successful completion of the degree. In most cases, students study without the safety net of the supervisory committee, which is common in the United States, and the level and quality of supervision of PhD students have met with criticism. A 1972 survey of social science students found that 37 per cent felt the quality of their supervision had been either mediocre or poor. There is an obvious danger, if supervisory arrangements are essentially one to one, that personality clashes and different academic perceptions may cause strains. One study found that at least half the students expressed mild or serious reservations about the supervision they had received. The study concluded that students are more likely to be satisfied if the supervisor is active in research, particularly in a similar area. There was no evidence that students were more satisfied if they worked with experienced supervisors, but students were more likely to be satisfied if their supervisor was closer to their own age. The main source of dissatisfaction appeared to be the nature of the relationship between the student and supervisor, ranging from personality clashes to lack of rapport (Welsh, 1978).

In recent years the supervisory and examination processes have been deliberately separated. In 1986, the Committee of Vice-Chancellors and Principals produced a report, under the chairmanship of Philip Reynolds, which recommended that supervisors should not normally act as examiners (a practice that had been common in some universities). As a consequence, it is now unusual to find them performing this double role, and in many institutions they will not usually be present at the *viva*. Normally, two examiners are appointed, an internal examiner knowledgeable about the general field and the university's procedures, and an external examiner who is an acknowledged authority on the thesis topic. The opinion of the external examiner is of great importance. This system has been used to maintain high standards of research work, but it can actively discourage any concern with the research training process, focusing as it does primarily on the finished product – the PhD thesis.

By contrast, in the United States, the student's advisers are normally members of the final examination panel, and there is a much stronger bond between the training process and the product. It is doubtful, however, whether the US system is as successful at establishing a universal standard for the award of a research degree.

Research training in the sciences

The training of research students in the laboratory sciences was influential in determining the conclusions of the ABRC report on postgraduate studies. Compared with most social science and non-laboratory science disciplines, the PhD completion rate for research students in the natural sciences was reasonably good. In many respects, research training in the natural sciences (frequent contact with the supervisor, working as part of a team on a large research project) is the model which other disciplines have been urged to adopt. The ABRC report criticised the completion rates, however: of those enrolling in 1976, 65 per cent of engineering students had completed their PhD after 3.75 years, 52 per cent of physics students, and 55 per cent of biological sciences students, but only 26 per cent of social science students (ABRC, 1992, pp. 29-30).

The four science research councils (Agricultural and Food Research Council, Medical Research Council, Natural Environment Research Council, Science and Engineering Research Council) all adopted a sanctions policy to ensure that a certain proportion of the students would submit their theses within four years. While it has been criticised as too blunt an instrument, this policy has been effective. Of the 2 453 students supported by the SERC to commence their studies in 1987, 66 per cent had completed within four years (SERC, 1992, p. 30).

Most research studentships in the sciences are allocated to institutions as quota awards, and the institutions decide which students to support. Universities are required to make biannual submissions to the largest funder of research training, SERC, for quota places, and must give details of the facilities and research training to be provided. The forms for autumn 1992, for example, required information on such topics as health and safety, project management, computing, report writing, and associated skills. On the basis of this information and peer review, institutions are then allocated quotas. Research students in the natural sciences do not usually complete a formal taught course before beginning PhD research, although the importance of including taught elements in doctoral training for physics students was emphasised by a national committee concerned with research organisation in physics in the late 1980s (see Clark, 1993, which also gives an excellent comparative study of graduate education in this respect).

A major effort has been made to ensure that the research skills provided in the sciences are those that industry requires. Under a number of initiatives, the research councils have successfully included private industry in the research training process. In the Co-operative Awards in Science and Engineering (CASE Scheme) industrial companies collaborate with academic departments on specific projects and provide financial support in addition to the SERC's basic stipend. They also provide facilities and accommodation for the student over an agreed period of time. Another mechanism for training science students is the Teaching Company Scheme, which has existed since 1974 and promotes the concept of research training partnerships. Originally, the scheme concentrated on engineering, but it has been extended to include the physical sciences, information technology, and the behavioural sciences.

Despite such programmes, engineering PhDs are criticised for being too narrow and too reliant on mathematical analysis, and it has been argued that holders of the engineering PhD are not well prepared to enter the engineering environment of industry with its practical and managerial requirements. The Parnaby Report (SERC, 1990) on the postgraduate research training of engineers recommended the introduction of a Doctor of Engineering degree similar to the Dr Ing qualification award by German technical universities. The new degree, which has been launched by the SERC in three centres, will train engineers in teams linked with industrial companies over a period of four and a half years. Instead of the traditional PhD thesis, the students are required to submit project reports and develop competencies needed in the engineering industry. If the scheme is a success, the SERC will probably switch more resources into this new form of research training and away from PhD research. Indeed, such doctorates have implications for developments in a range of disciplines.

A similar concern to broaden the science training base formed part of the recent proposals, from the Centre for Exploitation of Science and Technology (1992), to establish "Faraday Centres" as collaborative research bodies that reinforce research links between universities and industry. The recent government White Paper on science and technology, *Realising Our Potential* (1993), will have an important impact on the direction of research training, as it emphasises the critical links between universities and industrial research and development. In its submission to the report, the CVCP emphasised (1992) its wish to encourage postgraduate training partnerships with independent research organisations, and this seems likely to become an important development in the 1990s and beyond.

Guidelines for the social sciences: the response of the ESRC

The Economic and Social Research Council covers a range of social science disciplines (area studies, economic and social history, economics, education, geography, linguistics, planning, management and business studies, political science and international relations, psychology, social anthropology, social policy, socio-legal studies, sociology, and statistics, computing and methodology). In the early 1980s, it was found that the rate of thesis submissions among PhD candidates in these disciplines was low (Rothschild, 1982; ABRC, 1982; Winfield, 1987). As a result, a sanctions policy was introduced in the mid-1980s against higher education institutions with unsatisfactory submission rates. The submission rates were set as follows: 10 per cent in 1985, 25 per cent in 1986, 35 per cent in 1987, and 40 per cent in 1988. Currently the Council requires a submission rate of 50 per cent from ESRC-supported students who started four years earlier. In autumn 1992, an average national submission rate of 69 per cent had been achieved by ESRC-supported students who began their studies in 1988, and no institution was "blacklisted" (prevented from holding research council studentships for a two-year period). In this respect, the policies of the ESRC Training Board and Council have been effective in raising the level of submission among ESRC-supported students.

Yet this has to be seen in the context of a series of developments pioneered by the Training Board. Having introduced a sanctions policy linked to submission rates, the Board entered into a series of consultations with the social science constituency about the future shape of research training in the social sciences. On the basis of the responses received, 20 disciplinary groups were established to devise guidelines for research training (ESRC, 1991). Departments wishing to take students with ESRC awards then had to demonstrate that their training met the general and subject-specific ESRC guidelines, which involved providing courses for up to 60 per cent of a student's time in the first year on such topics as the philosophy of the social sciences, research design, quantitative and qualitative methods, the ethics and politics of social research, and study skills associated with computing, library work, and writing.

Teams of consultants considered whether departments had met the full range of criteria, which include:

- adequate provision of formal training;

- adequate arrangements for supervision;
- a good research environment (evaluated on the basis of publications);
- adequate student numbers;
- satisfactory thesis submission rate

Departments which provided evidence showing that they met all these criteria were given Mode A status, while those that met all the requirements apart from the formal research training were give Mode B status. In 1992, the criteria were only applied for full-time ESRC studentships, but from 1993 they also apply to part-time studentships.

Alongside these requirements for PhD training, the ESRC has also sought to forge links between the training provided for taught master's degrees and PhD training. In autumn 1992, those departments that wanted their master's courses recognised by ESRC also had to apply for recognition. At that stage, departments could also apply for recognition, including an additional weighting for research training, but in that case, additional criteria had to be met. These included the provision of research training appropriate to the academic discipline or disciplines, on the basis of the criteria that had been established in the Postgraduate Training Guidelines.

Thus, the ESRC has sought to raise the level of training provided for the students it supports directly. However, it is also hoped that such training will be provided for all social science postgraduates, thus raising the level of research competence available to the social science community in the late 1990s. The debates about submission and research training within the ESRC have also influenced other bodies, especially the British Academy.

Research training in the humanities: the British Academy/CVCP report

The British Academy is responsible for the award scheme which provides for postgraduate research studentships in the humanities in England and Wales. In July 1991, the British Academy and the Academic Standards Group of the Committee of Vice-Chancellors and Principals established a working group to consider the purpose and structure of postgraduate research in the humanities and the award scheme that provides for it. The group was established in response to widespread concern about the low submission and completion rates of postgraduates receiving British Academy awards for doctoral research. The British Academy's surveys, conducted in November 1991, indicated that only a third of award holders submit a thesis within four years, and a half within six years, while approximately a third never complete a thesis (British Academy/CVCP, 1992, para. 3). After a wide consultation process with all sectors of higher education, the group's final report (1992) made proposals in three main areas.

The requirement of the humanities doctoral thesis

The review group considered that the scale and scope of the doctoral thesis in the humanities needed to be redefined. It argued that it is unreasonable to expect students to

produce a publishable and significant thesis, which does not require substantial modification, in three or four years. Instead, it recommended that universities "review their regulations to state explicitly that a doctoral thesis should be a piece of work which a capable, well-qualified and diligent student, who is properly supervised and supported, can produce in three years. It would exhibit substantial evidence of original scholarship and can be prepared for publication" (paras. 11-12).

The group concluded that if this definition was generally accepted, a larger number of successful doctoral theses would be submitted. The review group was also concerned that many students embark on inadequately defined and planned research projects and have unrealistic expectations about what they will achieve. The report recommended, therefore, that from 1993 the assessment of a research project by referees and institutions, a requisite part of an application for an Academy award, should indicate whether the proposed project can be completed within three years and that this information should be taken into account in the awards competition (para. 16).

Research training and a revised system of awards

The review group judged that in many areas of research in the humanities, a first degree does not provide an adequate foundation for doctoral research and that a period of further training is necessary before beginning a doctoral thesis. The report proposed that from 1993 postgraduate research students in the humanities should undergo one year's training before being eligible to apply for a British Academy research award; this training might, but need not, lead to the award of a master's degree. The report recognised that the necessary training and preparation may differ considerably from one discipline to another: in some disciplines, courses in bibliography, computing, statistics, or languages may be prerequisites for research; in others, the only practicable way to be trained in research may be to engage in research under the supervision of a senior scholar. The review group considered and rejected the idea of producing research training guidelines similar to those issued by the ESRC. The report concluded that it was the primary responsibility of individual departments to ensure that students receive adequate training in order to complete a doctoral thesis satisfactorily and become professionally trained in their subject. The group also invited institutions and subject groups to develop their own guidelines on appropriate training (paras. 19-20, 23).

In order to provide for the year of research training, the report recommended that the British Academy revise its system of awards by introducing a "one-plus-three" model of studentships, in order to allow a student to receive a maximum of four years' funding to cover one year of training and three years of research towards a doctorate. The majority of three-year research awards should only be available to students who have undertaken an initial year of postgraduate training. Applicants for British Academy awards and the institutions where they intend to study will have to provide, on the application forms, statements on the training required and how it will be provided; this information will be taken into account when judging applications for awards (paras. 28, 30-33, 40-44). The report also recommends that a limited number of three-year awards continue to be offered

to applicants with no experience at postgraduate level, and that submission and completion rates be closely monitored for comparison with students on "one-plus-three" awards (para. 41).

Supervision

Inadequate supervision is cited as the major reason for low submission and completion rates. The review group recognised the progress universities have made in recent years to improve the quality of supervision, but felt that it was difficult for some supervisors in the humanities to develop their expertise in supervising research students, since they supervise so few in the course of their careers. The report therefore recommended that the Academy should consider drafting an addition to the CVCP's *Code of Practice on Postgraduate Training and Research* (1986), to set out the responsibilities of supervisors in the humanities. It also recommended that the Academy should further scrutinise supervisory arrangements and the environment in which doctoral research is to be undertaken. Finally, institutions are encouraged to develop, in concert with the CVCP's Staff Development Unit, training programmes for supervisors in the humanities (paras. 17-18).

Finance for research training: the research councils

The main source of financial support for UK and European Union (EU) students undertaking postgraduate research training at UK universities is provided by the studentship schemes administered by the four research councils (for the sciences), the Economic and Social Research Council (for the social sciences) and the British Academy (for the humanities). However, while students from Scotland may apply to the research councils, they must apply to the Scottish Education Department (SED) for research studentships in the humanities; residents of Northern Ireland are only eligible for MRC awards, but the Department of Education for Northern Ireland (DENI) offers postgraduate studentships in most other subjects.

The research councils are public bodies, funded by the government. Most make awards of three years' duration to full-time postgraduate students undertaking research towards an MPhil/PhD at an institution of higher education in the United Kingdom. The terms and conditions of the studentship schemes vary among the research councils, but most restrict eligibility to UK or EU residents who have obtained, or can expect to obtain, the equivalent of a second class honours degree. In the case of UK students, research studentships pay the academic fees and a maintenance allowance of around £4 500 per annum, with additional discretionary allowances available for dependents, relevant experience, and travel. EU students receive a fees-only award. It has been estimated that only 35 per cent of all doctoral candidates are supported by studentships from the research councils and the British Academy. Although no hard evidence is available, it is clear that many students are supported by their own funds, employers, or private foundations (Henkel and Kogan, 1993). The studentship schemes of the three principal public funding bodies are as follows.

Economic and Social Research Council

Each year, on the basis of a national competition, the ESRC makes approximately 300 research awards for full-time postgraduate research training leading to MPhil/PhD qualifications in the social sciences at recognised institutions of higher education in the United Kingdom. As noted above, the ESRC recognises two types of status for departments within institutions: Mode A and B. Mode A departments have demonstrated that they can provide formal training in research methods and techniques in the first or foundation year of a doctoral programme, in line with the ESRC's Postgraduate Training Guidelines. Mode A departments may take ESRC-funded students without previous postgraduate research training for full three-year awards. Mode B departments can only take ESRC-funded students who have received a foundation in research training, usually through a master's programme which teaches research methods, or who have taken the first year of a PhD programme elsewhere.

Science and Engineering Research Council

The SERC awards approximately 2 355 research studentships each year. These research studentships are tenable for up to three years to postgraduates undertaking training in research methods in a doctoral programme in science and engineering. There are two types of awards: "standard" and CASE. The majority are standard awards, which are allocated by the SERC, as quotas, to departments in institutions. Heads of departments then nominate eligible candidates for these studentships up to the limit of their quota. A small number of "standard" awards are also available for competition through "appeal" to the SERC. Co-operative Awards in Science and Engineering (CASE) are designed to give students experience of research in an industrial environment on a project jointly supervised by a staff member from an academic institution and an employee of a UK industrial firm or an organisation in the public service (the co-operating body). CASE awards include a mandatory contribution to the student from the "co-operating body". CASE awards are also allocated to departments by quota.

British Academy

Until 1992, the British Academy, through its national awards competition, gave approximately 500 "major state studentships" each year. The majority of these awards provided three years of funding to residents of England and Wales who undertook research in the humanities. As noted above, the 1992 British Academy/CVCP Report proposed a system of "one-plus-three" awards, increasing the number of one-year awards and offering 400 three-year awards each year. Of the latter, 100 would be available on the old model to students without postgraduate experience, and 300 would be restricted to students with one year's postgraduate research training under the "one-plus-three" arrangement. Such students might have already received a year of funding from the British Academy to undertake a master's degree providing them with the requisite training. Under the new arrangements, they would be eligible for a further three years' funding for a doctorate.

Alternative sources of funding

Sources of support for students who do not receive research council or British Academy support are relatively limited. Indeed, only the ESRC has started (from October 1993) to fund, through a national competition, part-time postgraduates. Many part-time doctoral students finance their own studies, and some are financed by their employers, although this is more common for taught master's degrees than for PhDs, given the link between master's degrees and employment. Some universities provide their own scholarships, mainly for students who have been unsuccessful in the research council and British Academy competitions. In 1992, institutional scholarships were available at: Edinburgh (27), Sheffield (70), London School of Economics (30 scholarships and 45 bursaries), Sussex (12 scholarships and 6 fees-only awards). A scholarship generally involves a maintenance award (equivalent to a research council or British Academy grant) together with payment of fees, while for fees-only awards maintenance has to be obtained elsewhere; bursaries often mean that fees and additional maintenance need to be found elsewhere, with the result that many part-time students work over extended periods.

Universities have also devised some work schemes. In addition to employing graduate students as class teachers on a casual basis, they have also developed teaching assistant programmes. At the University of Warwick, this programme involves teaching for up to 150 hours over 30 weeks of the year. In return, teaching assistants are paid the equivalent of a research council or British Academy award, have their fees paid, and receive training in teaching. Thus, the scheme is intended to develop graduate training and to equip those involved to assume teaching posts in higher education at the end of four years.

Student motives for undertaking research degrees

Students who decide to enter a period of postgraduate research training do so for a variety of reasons. The single most important motive is a desire to study in greater depth a field in which they have a special interest, and this is also important to sustaining the energy and commitment required to complete the degree (Rudd, 1985, p. 23). A desire to enhance research skills for vocational reasons is another important motivational force.

Some students, however, tend just to drift into a research degree. The attractiveness of university life and uncertain employment prospects lead some students to opt for research training as the best of a poor set of alternative career prospects, particularly students able to continue at the institution where they completed their first degree. For example, at the University of Warwick, approximately one-third of all research students previously studied at the University, either as undergraduates or on taught postgraduate courses; the pool of third-year undergraduates is an important recruitment source for postgraduate research training in all UK universities. It is unfortunate that some students undertake research training with little motivation; although there is little research evidence on this topic, it would appear that such students are not likely to have the commitment necessary to undergo three years of research training (Rudd and Hatch, 1968, Walford 1980).

The student experience

Many research students suffer from a sense of social and intellectual isolation. Postgraduates tend to withdraw from student activities and concentrate on their academic work; they do not play a full role in the social and cultural life of universities. Many find it difficult to adjust from their previous employment or undergraduate experience. While there is little research evidence to suggest that a sense of intellectual isolation increases drop-out rates or otherwise impairs the efficiency of training, it may contribute to the sense of disenchantment or boredom with research which has been identified as an obstacle to the successful completion of research training. Unfortunately, many research students experience boredom and frustration at some stage of their studies.

Informal socialisation into the culture of universities was found by Burgess *et al.* (1992) to be an essential part of postgraduate work (see also Phillips and Pugh, 1987). Many universities in the United Kingdom have responded by encouraging postgraduate societies and providing social facilities for their students. Some evidence suggests, however, that graduates tend to make little use of common room facilities, for example, even when they are made available (Rudd, 1975, pp. 66-87). A National Postgraduate Committee has been established to examine postgraduate study from a student perspective. It works with students and institutions to try to handle some of the problems of postgraduate study. However, it may be impossible to reach satisfactory solutions to the difficulties associated with graduate work.

Postgraduates are concerned about financial support. A recent survey at Edinburgh University showed that 20 per cent had considered withdrawing at some stage because of financial problems, and some 80 per cent used their own savings to help finance their studies. The facilities available for research students also give cause for concern. It is unfortunately the case that by no means all research students have access to adequate laboratory or office space, or even access to a library carrel. They often work at home, and this increases their sense of isolation. It would be wrong, however, to overemphasise these problem areas on the basis of limited information. The majority of students successfully complete their research training, and the obstacles identified above, if present, are not sufficient to undermine the research training process.

The labour market: employment prospects and the demand for researchers

Any general discussion of labour market demand for postgraduates must concern itself with broad labour-market trends. Different employment sectors have need of different kinds of postgraduates, in terms of disciplinary specialisations and associated research skills. It is also necessary to set the discussion of postgraduate labour market trends in the context of overall trends in the graduate labour market and to recognise that the initial decision to take up postgraduate study may be influenced by the labour market situation.

In a discussion of postgraduate research training output, Holland (1988) drew attention to the fact that reliable statistics on the first destination of new doctorates are difficult to compile and generally do not exist in any systematic form. While statistics may be kept

in a variety of different locations [by the institution of registration, by the body making the research award, by the Association of Graduate Careers Advisory Services (AGCAS)], the geographical mobility of postgraduates and the range of different practices relating to the end of research studentships, entry into the labour market, and the awarding of the doctorate often mean that the available statistics are at best partial. As various commentators have pointed out, the paucity of statistics on postgraduates has been a cause for concern among policy makers (Advisory Board for the Research Councils, 1982, 1987; Walford, 1983). Furthermore, in the light of this lack of data, the basis upon which proposals for funding and managing research have been produced has been questioned. Clayton (1988, p. 21) states: "We face the paradox that proposals for funding and managing research, itself a skilled, difficult and sophisticated activity, have been introduced with no empirical investigation, no modelling of their effects and no suggestion that their operation might be monitored."

Conscious of the lack of data on employment trends and postgraduates, various research and monitoring projects have been commissioned by the research funding bodies in an attempt to provide baseline data on the career paths of postgraduates and to go some way towards assessing the impact of postgraduate training on the labour market and on the economy more generally. While some of these studies have been specific to a particular discipline (Pole, 1988), others have reported on data collected from a range of disciplines grouped under the generic title of social sciences (Pole and Pearson, 1988). These studies provide an important guide to a range of issues relating to labour market demands for postgraduates, but they do not provide comprehensive coverage of all disciplines within the arts, social sciences, and natural sciences.

Labour market demand for social science postgraduates

The Institute of Manpower Studies (IMS) has reported that little systematic evidence has been collected on labour market requirements for postgraduate social scientists, and, moreover, that the likely contribution of such graduates to the needs of the economy has been questioned (IMS, 1991).

The findings of the IMS survey of employers' demands for postgraduate social scientists are underpinned by more general labour market data illustrating that the demand for doctoral social scientists is extremely small and fragmented. Furthermore, the demand varies among disciplines, thus making generalisation difficult. However, general trends in the IMS data confirm those identified by Rudd (1990), which suggest that general labour market demand for postgraduate social scientists is slight, with only the university teaching sector employing significant numbers of PhDs in this area. Rudd's data show that of the 168 respondents to his survey who were in university teaching, 114 (68 per cent) had gained PhDs. While the IMS reports a smaller (33 per cent) percentage of doctoral social scientists entering employment in UK higher education on completion of their full-time studies, the trends are very similar to those identified by Rudd. A further 13 per cent are employed by research or other educational establishments, and less than 10 per cent find employment in industry and commerce.

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While the proportion of doctoral social scientists working outside academia is small, this situation needs to be seen against the career aspirations of the group as a whole. Again, IMS data provide a guide and show that two-thirds of the 354 UK students expressed the wish to work in higher education either as researchers or as teachers. Less than one-third intended to move into what was described as "non-research-related work". Matching career aspirations with first destination data would, in this case, seem to indicate that many social scientists are likely to achieve their goals. It should not be inferred from these broad statistical data, however, that jobs in academia are always readily available for doctoral social scientists. IMS respondents reported difficulties relating to the availability of suitable vacancies or posts in higher education, while those who intended to work outside of academia reported that employers considered them both overqualified and, at the same time, to have research experience that was too narrow or not suitable for industry and commerce. Despite these difficulties, 85 per cent of respondents eventually managed to find suitable employment, with sociologists experiencing the greatest degree of difficulty and those with doctorates in business, accounting, and economics the least.

Overall, employment trends for social scientists indicate that higher education is by far the major employer. Moreover, it would appear that few employers had any particular demand for social scientists with doctorates. For example, of the 120 employing organisations taking part in the IMS study, only 45 had employed a postgraduate social scientist in the 12 months immediately prior to the study. "Given the small fragmented demand for doctoral social scientists, few employers had a specific recruitment strategy towards them and they were largely an invisible sub-set of the broader graduate and postgraduate intakes" (IMS, 1991, p. 6).

Salary levels

In a survey of graduates gaining first degrees in all subjects in 1970, Williamson (1981) found that those without any postgraduate qualification tended to earn more than those with PhDs. While PhDs tend to enter employment with a higher starting salary than those with first degrees, Pole and Connor (1988) showed that the median starting salary for higher degrees across all disciplines and industry sectors was £1 000 above the median for first degree graduates; however, the difference was not great enough to put them on a par with their peers who left higher education after first degrees. The three or four years in employment often meant that the first degree graduates received salaries above those of PhD graduates, whose starting salaries did not take adequate account of the three or four years spent in doctoral study (Pole and Connor, 1988).

On this topic, Rudd (1990) discusses the assertion that in subsequent years the earnings of PhDs pull ahead of those of first degree graduates; he concludes that in order for lifetime earnings of PhDs to equal those of people with first degrees, their mid-career salaries need not merely to equal but to overtake those of the latter. A survey of scientists and engineers undertaken by the Technical Change Centre for SERC found that by the age of 40-50 this had not yet happened (Rudd, 1986).

Given that the majority of those who gain PhDs enter employment within higher education, where, as Rudd (1990) claims, salaries have been held down by government policy, it seems unlikely that their salaries will ever overtake those of their peer group who entered the labour market after first degrees. Furthermore, when PhD holders enter employment outside of academia, they are usually employed in positions for which a PhD is not obligatory. As a result, they compete for salaries and promotion not on the basis of their formal qualifications, but on a range of criteria related to how well they do their job. The available research evidence seems to suggest that employees with PhDs are not necessarily any better equipped to compete on the basis of such criteria than first degree graduates. Moreover, employers' greater regard for job experience than for qualifications that may or may not be related may mean that PhD recruits are in fact at a disadvantage.

Overall, the possession of a doctorate would not seem to enhance the earning potential of employees in a labour market that has very few specific requirements for skills and knowledge acquired during three or four years of study.

Labour market demands for natural science postgraduates

Comprehensive information relating to labour market demands for natural scientists is also difficult to locate. Connor and Varlaam (1986) conducted a study of the employment and careers of science postgraduates, comparing the experiences of doctoral graduates in the four main science disciplines: biological sciences, mathematics, chemistry, and physics. In addition, studies of separate disciplines have been commissioned by the Science and Engineering Research Council (Pole, 1988; Pole and Pearson, 1988).

Evidence from these studies suggests that the picture for natural scientists is not significantly different from that for social scientists. Labour market demand for those with a doctorate in a natural science discipline remains small and highly specialised, and many employers recruit PhD graduates as part of their general graduate recruitment programme. For some labour market areas, notably institutions of higher education and advanced research institutions, a PhD is a requirement of appointment. Similarly, in some applied areas of biological sciences, doctoral scientists to conduct highly specialised research are in demand.

In the case of nuclear and particle physicists, a survey of 337 doctoral students whose SERC awards terminated between 1980 and 1986 found that a majority of respondents entered employment soon after completing their postgraduate studies (Pole, 1988). Many (67 per cent) experienced little difficulty in securing the type of employment they wanted, and very few had experienced unemployment after the end of their award. For these highly qualified specialists, labour market demand was high and career paths were fairly rapid during the early years. Most respondents remained in their first job for less than two years. Furthermore, jobs overseas accounted for more than one-quarter of first destinations, although there was some evidence to suggest that physicists were returning to the United Kingdom for subsequent jobs. In addition to specific subject content, physicists valued their training in research techniques and the chance to develop analytical skills which their research had afforded. Many of these skills were seen as transferable to various jobs.

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The institutional response

Much of the pressure to reform the postgraduate research training process in the 1980s came from agencies responsible for funding the training rather than from the universities that provided it. There was, indeed, considerable opposition within universities to the introduction of the research councils' sanctions policy and considerable argument about the nature of the PhD. The debate has now moved on; it is widely accepted that the PhD is an original contribution to knowledge carried out as part of a research training process within a fixed period of time. The present concern is to ensure that institutional policies and practices are conducive to the production of trained researchers. In the United Kingdom, the academic structures of most universities were developed primarily to cater for undergraduates. In most cases, this was not a deliberate policy but simply the result of the pressure of undergraduate numbers and limited resources. Graduate education is, in the main, managed as an extension of undergraduate programmes, often without the dedicated resources necessary for high-quality activity.

Part of the problem in the United Kingdom has been the size of the postgraduate training programmes. In 1982, it was estimated that 44 per cent of university science and social science departments had fewer than 16 research students (ABRC, 1982, p. 25). Many departments may be too small to support a doctoral programme with a thriving graduate community. While both the MRC and AFRC have deliberately attempted to concentrate postgraduate research training, there are no significant moves towards concentration across the system as a whole. Recent changes to higher education have sent rather confused messages for the future of postgraduate research training. The abolition of the distinction between universities and polytechnics implies that an increasing number of institutions will engage in basic and strategic research. The newly-designated universities, which have only recently secured the privilege of awarding research degrees in their own name, have made efforts to increase numbers of research students. However, it is widely believed that the 1990s will see basic and strategic research increasingly concentrated in selected institutions; this obviously has implications for the location of research training.

It is probable, although by no means certain, that institutions will place increased emphasis on the importance of their research training activity. In the early 1980s, 60 per cent of science and social science departments thought that research students made an important contribution to the research capability of the department, whereas only 30 per cent of departments disagreed with this proposition. The inclusion of information about postgraduate research students as a performance indicator in the Universities Funding Council's 1992 research assessment exercise should help to emphasise the importance of research students to the departmental research effort. However it is possible that, in a system which is rapidly expanding its numbers of first degree students, postgraduates will be squeezed. The 1991 Government White Paper on the future of higher education envisaged an increase in undergraduate numbers between the years 1989 and 2000 of 71 per cent, but only a modest increase of 14 per cent in postgraduate numbers during the same period. The future institutional emphasis on postgraduate research training therefore remains uncertain.

There is no doubt that universities have made efforts to reform the postgraduate research training process. There has been a move away from the apprenticeship model of one-to-one research supervision towards a programme of research training that includes taught elements, the appointment of joint supervisors, and a careful monitoring of progress by a research committee. Perhaps most significant of all, virtually all institutions now have strict limits on the length of research theses, which typically restrict a PhD to between 70 000 and 100 000 words. This has probably been the most important institutional step to encourage rapid completion. The actual limit is less important than the message it helps convey about the nature of the PhD. Many institutions now register all research students for an MPhil degree in the first instance and only upgrade the registration to PhD if progress is satisfactory.

In order to manage these quality control mechanisms, some institutions have looked to the American graduate school model. In January 1991, the University of Warwick established a Graduate School to promote high-quality graduate education across the entire institution. University College London has had a fully operational graduate school since October 1992 to help promote a corporate identity throughout the college for all research and graduate activity. There are indications that at certain other institutions the administration of graduate education will also be changed in the 1990s. The University of Manchester has established research and graduate schools in each faculty. Meanwhile, many other universities are considering reorganising their graduate administration by establishing some sort of graduate school or schools.

The University of Bath has recently appointed a postgraduate ombudsman on a trial basis to help alleviate the problems faced by some postgraduate students in connection with standards of supervision. Some institutions are establishing research consortia to pool their training expertise. Interdisciplinary training programmes cutting across individual departmental boundaries have been established. Eight Scottish universities have established a consortium for training PhDs in economics, and eight universities in south-west England and in Wales have pooled resources to provide improved training for geography research students.

However, most institutions have not yet adopted new structures for the management of postgraduate research training. Indeed, it remains an open question whether these initiatives can be adopted and adapted across the higher education system as a whole. Nevertheless, graduate education and graduate schools have a high profile in current debate in the United Kingdom. In January 1993, the ESRC initiated a consultation exercise concerning the research infrastructure for the social sciences (ESRC, 1993) which included a discussion of graduate schools, and an initial meeting and a summer conference have been held to establish a UK Council for Graduate Education. Finally, the government has issued a White Paper entitled *Realising Our Potential* (1993) which advocates that a one year MA or MSc course be taken before a PhD – an idea that is now being examined by institutions. Clearly, there is much to discuss about the future of graduate education in higher education institutions, and the results of those discussions will influence the shape and substance of research training for UK postgraduates.

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Chapter 7

POSTGRADUATE RESEARCH TRAINING IN THE UNITED STATES

by

Jules B. Lapidus, Peter D. Syverson and Stephen R. Welch

Council of Graduate Schools, Washington, DC

Introduction

Higher education in the United States

In order to understand American postgraduate research training, several points about higher education in the United States need to be established. Perhaps the most important is the fact that the federal government has no direct control over universities and colleges. There is no ministry of education or its equivalent, and while the federal government spends billions of dollars each year in support of research projects, research facilities, student fellowships, and student loans, it does not provide direct financial support for the basic operation of institutions of higher education and has no direct role in institutional administrative or academic policy setting.

Thus, there is no system of higher education in the United States. Instead, there are approximately 3 500 institutions, some supported by private funds, some by funds provided by the states and representing, in their diversity, every imaginable variation in size, location, mission, programme offerings, and type of student body. The public institutions are subject to control by the states in which they are located, and different states have different approaches to supporting such institutions. Private institutions are responsive to their governing boards for determining their size, scope and mission. Thus, each institution is somewhat different.

That being said, there are certain similarities that allow for convenient groupings. Perhaps the best known of these (and most relevant to this discussion) is the Carnegie system, which classifies universities and colleges on the basis of several factors, as illustrated in the following box. (The Carnegie system has no official status; it is simply a categorisation based on arbitrary but widely accepted criteria.)

Carnegie Classifications

Research Universities I: These institutions offer a full range of baccalaureate programmes, are committed to graduate education through the doctorate degree, and give high priority to research. They receive annually at least $33.5 million in federal support and award at least 50 PhD degrees each year.

Universities II: These institutions offer a full range of baccalaureate programmes, are committed to graduate education through the doctorate degree, and give high priority to research. They receive annually between $12.5 million and $33.5 million in federal support for research and development and award at least 50 PhD degrees each year.

Doctorate-granting Universities I: In addition to offering a full range of baccalaureate programmes, the mission of these institutions includes a commitment to graduate education through the doctorate degree. They award at least 40 PhD degrees annually in five or more academic disciplines.

Doctorate-granting Universities II: In addition to offering a full range of baccalaureate programmes, the mission of these institutions includes a commitment to graduate education through the doctorate degree. They award annually 20 or more PhD degrees in at least one discipline or ten or more PhD degrees in three or more disciplines.

Comprehensive Universities and Colleges I: These institutions offer baccalaureate programmes and, with few exceptions, graduate education through the master's degree. More than half of their baccalaureate degrees are awarded in two or more occupational or professional disciplines such as engineering or business administration. All the institutions in this group enroll at least 2 500 students.

Comprehensive Universities and colleges II: These institutions award more than half their baccalaureate degrees in two or more occupational or professional disciplines, such as engineering or business administration, and many also offer graduate education through the master's degree. All of the colleges and universities in this group enroll between 1 500 and 2 500 students.

Liberal Arts Colleges I: These highly selective institutions are primarily undergraduate colleges that award more than half their baccalaureate degrees in arts and science fields.

Liberal Arts Colleges II: These institutions are primarily undergraduate colleges that are less selective and award more than half their degrees in liberal arts fields. This category also includes a group of colleges that award **less** than half their degrees in liberal arts fields but, with fewer than 1 500 students, are too small to be considered comprehensive.

Professional Schools and Other Specialised Institutions: These institutions offer degrees ranging from the bachelor's to the doctorate. At least half of the degrees awarded by these institutions are in a single specialised field. Specialised institutions include: medical schools and medical centers, schools of engineering and technology, schools of business and management, and teachers' colleges.

Two-Year Community, Junior and Technical Colleges: These institutions offer certificate or degree programmes through the Associate of Arts level and, with few exceptions, offer no baccalaureate degrees.

Source: The Carnegie Foundation for the Advancement of Teaching, 1987.

Research training can take place at institutions in any class, but the most significant institutional commitment to research and research training is primarily in the group referred to as the research-intensive universities, that is, the Research I and Research II institutions and, to a lesser extent, at other institutions granting the doctoral degree.

Graduate education

Graduate education is the term used to refer to certain programmes of study beyond the baccalaureate degree. The two principal graduate degrees are the master's degree and the doctoral degree, and of the approximately 1.4 million graduate students in the United States, approximately 300 000 are enrolled in doctoral programmes. In terms of numbers, approximately 320 000 master's degrees and 37 000 doctoral degrees are awarded each year. The different fields of study number in the hundreds. Thus, the term graduate education is a very broad one, used to describe a large and heterogeneous enterprise. The term doctoral education is more precise, defining those programmes leading to research-oriented doctoral degrees, primarily the PhD; students in programmes leading to degrees such as Doctor of Medicine (M.D.), Doctor of Jurisprudence (J.D.), Doctor of Dental Surgery (D.D.S.), and other similar degrees are not referred to as either graduate or doctoral students, but as professional students.

The American graduate school

Almost all American universities engaged in graduate education maintain administrative units called graduate schools. In some universities there are several such units: a Graduate School of Arts and Sciences, and sometimes, depending on the institution, a Graduate School of Business, a Graduate School of Education, or other specialised graduate schools. This type of structure is characteristic of privately supported universities; and examples are Harvard, Yale, and Princeton. In other universities, usually the larger, publicly-supported universities, there is a single graduate school, with administrative responsibility for all graduate programmes. Examples are the University of California at Berkeley, the Ohio State University, the University of Wisconsin, and the University of Washington.

The heads of these units usually have the title of Dean of the Graduate School, or Dean of Graduate Studies, and may also, depending on the institution, be the primary research officer, often with a title of Vice-President or Vice-Provost for Research. Since the research activities of the faculty and students are usually connected with graduate programmes, some universities have found it convenient to locate the administration of these activities in one office. The individual holding either or both of these titles is always a senior member of the faculty.

The graduate school is an unusual administrative unit. Its faculty are all the faculty members of the institution involved in graduate education, but the faculty are not employed by the graduate school. They are employed by the college in which their

department resides. Its students are all of the graduate students in the institution, and it serves as the unit that offers or denies admission, maintains student records and information systems, and recommends the awarding of degrees. This is done in conjunction with the graduate faculty in the various departments under the administrative purview of the graduate school. It also provides a governance structure, usually by means of a graduate council made up of faculty, which often includes students. This is the key to understanding how a graduate school works. The graduate school is entrusted with defining and maintaining standards in all units. It does so by setting standards for admission which departments may exceed, but not drop below, and by establishing general requirements for all graduate degrees. Obviously, the substance of these requirements will differ from discipline to discipline, but all disciplines must develop appropriate examinations and set research requirements. In addition, the graduate school, using committees of the graduate council, usually reviews all requests for new graduate programmes and conducts periodic reviews of all graduate programmes.

By saying that the graduate school does these things, what is meant is that the graduate school, through its authority to convene a council and by its contacts with all graduate programmes, develops a consensus with regard to standards for quality that is acceptable to the entire graduate faculty and then serves as the administrative office entrusted with maintaining these standards. For example, it is usual in programmes leading to the PhD degree that all students are required to pass a comprehensive examination given by the faculty in their department or programme and designed to determine whether the student has assimilated and can use the knowledge in his or her field. While this examination will differ greatly in its particulars – between, for example, chemistry and history – all programmes must have an examination of this type. Similarly, the graduate school requires that all students seeking the PhD degree complete a dissertation demonstrating the ability to do a substantial and original piece of independent research that makes a contribution to knowledge. The standards for acceptance rest with the faculty in the student's programme, but all programmes must have such a requirement. Thus, a major purpose of a graduate school is to assure equity among all programmes and, by codifying requirements for all degrees, to ensure that students are aware of the requirements and are treated fairly.

The graduate dean plays another important role. This individual is usually the only person in the university whose sole responsibility is graduate education. The graduate dean is an advocate for scholarship, for research, and for graduate students and faculty in all departments and colleges of the institution. In this role the graduate dean's activities may be primarily political, since the graduate dean can interact with faculty and administrators across department and college lines and can provide neutral ground for the development of interdisciplinary programmes, new degree programmes, and all discussions of policy and practice related to graduate education and research. Graduate deans can serve as "trusted brokers" whose interest is promoting scholarship and good graduate education. The graduate school, then, is more than an administrative office; it is the link among all units of the university with graduate programmes, and, in a way, serves as the "invisible college" for all students, faculty, and administrators who are involved in graduate education.

Degree structures and research training

The only degree in the university specifically involving research as its major and indispensable component is the PhD degree. Students may also be involved in research as parts of other programmes, and some of these will be discussed briefly before looking more closely at the PhD.

Undergraduate research

Undergraduate students may become involved in research prior to receiving the baccalaureate (B.A. or B.S.) degree. This usually occurs either through the actions of individual faculty members who may offer a good student the opportunity to work on a research project, or through organised programmes designed to allow students to obtain some research experience. One example of the latter type is the Summer Research Opportunity Program (SROP) currently being used to identify promising undergraduate students who may be interested in graduate work. There are also research opportunities for students in special honours programmes. These are not degree-granting, or even credit-bearing programmes; they are simply opportunities for students to be involved in research under faculty supervision. Their purpose is not so much to produce research as to stimulate student interest in research through direct experience.

The master's degree

The master's degree is usually awarded for one or two years' academic work beyond the baccalaureate. At one time, the majority of master's degree programmes required that the student complete a thesis describing a research project. These projects were limited in scope and designed to introduce the student to research. In recent years, however, the majority of master's degrees have been awarded for course work programmes, and most of these are in professional rather than academic areas. The intent of these programmes is to prepare people for professional practice in fields such as business, public administration, social work, public health, and other areas. It is still fairly common for students in engineering to do a research thesis, largely because the master's degree in engineering is still viewed as appropriate preparation for much industrial research. In other fields, such as chemistry and physics, where most students are admitted with the assumption that they will work towards the PhD degree, many students bypass the master's degree altogether. Thus, in some fields, the master's degree is no longer used as research training, but in others, and particularly in institutions that do not grant the PhD, the master's degree still plays an important role in research training.

The doctoral degree

Although there are a number of different doctoral degrees involving research, the primary research degree offered by American universities is the Doctor of Philosophy (PhD) degree. This degree is offered by approximately 400 universities, with annual

degree production varying from less than ten per year at some institutions to over 700 at others. The degree is offered in all fields of arts and sciences as well as in professional fields such as engineering, education, agriculture, and health sciences. Not all institutions offer degrees in all fields. The large public research universities may offer doctoral degrees in over 100 fields, while other smaller institutions may offer the doctoral degree in only a few. The remainder of the discussion in this paper will be limited, for the most part, to the PhD degree.

Dimensions of graduate education and research training in the United States

More than 1 200 institutions offer a wide variety of graduate programmes, at the master's and doctoral level, and nearly 1.4 million students participate in graduate programmes each year. According to Table 7.1, graduate enrolment at the 588 institutions surveyed by the Council of Graduate Schools totalled 1.13 million in the fall of 1991. These students were enrolled in programmes in fields ranging from sciences and engineering through the humanities, education, and professional fields such as business and public administration. More than one-half of all graduate students are female, making it one of the most gender-balanced areas of American higher education.

Most students in graduate programmes in the United States are involved in career-related, or professional study. Typically, career-related study occurs at the master's degree level. Here, the largest areas are education and professional fields, which accounted for more than half a million students in 1991. Most of the enrolment in the professional fields area is in business and public administration. The third largest major field is the life sciences, with 116 338 students in 1991. As with business and professional fields, much of the graduate enrolment in the life sciences is in career-related master's degree programmes, with nursing the largest field of study.

Table 7.1. **Graduate enrolment by field, Fall 1991**

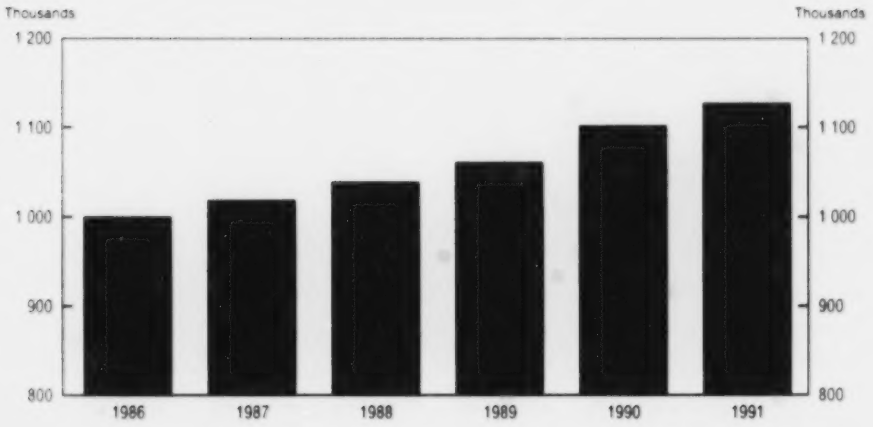
	Total	Men	%	Women	%
All fields	1 125 653	537 007	**49**	568 104	**51**
Education	229 984	58 605	**27**	160 471	**73**
Engineering	99 919	84 756	**86**	13 378	**14**
Humanities and arts	94 709	41 734	**45**	51 383	**55**
Life Sciences	116 338	45 072	**39**	69 529	**61**
Physical sciences	92 122	66 432	**73**	24 472	**27**
Social sciences	95 916	43 517	**46**	50 734	**54**
Professional/other[1]	302 909	154 018	**52**	140 113	**48**

Notes: Because not all institutions responded to all items, detail variables may not sum to total. Percentages are based on total of known gender.

1. Includes business, public administration, architecture, communication, home economics, library sciences, and religion.

Source: Syverson and Welsh, 1992.

Figure 7.1. **Graduate enrolment in the United States, 1986-91**



Source: Syverson and Welch, 1993.

Student demand for graduate education has increased steadily since the mid-1980s. As displayed in Figure 7.1, graduate enrolment has grown by 2 per cent each year since 1986. In recent years, the increase in graduate applications has outpaced the increase in enrolments. The number of applications received by US graduate schools increased at a 6 per cent annual rate over 1986-91, and since 1989, the increase has been 9 per cent per year. While a substantial part of that increase can be attributed to a recession-related demand for master's-level study, it is estimated that enrolment at the doctoral level has increased in recent years as well.

Although there are no national data that distinguish precisely between enrolment in master's programmes and doctoral programmes, results from the National Post-secondary Student Aid Study make it possible to estimate that roughly 80 per cent of all graduate students are pursuing master's degrees, and 20 per cent are involved in doctoral study. That means that of the 1.4 million graduate students, 1.1 million are studying at the master's level and 300 000 at the doctoral level.

However, it is possible to separate doctoral from master's study through the use of data on graduate degrees. Because most research training occurs at the doctoral level, the focus of the discussion that follows will be on doctoral study, especially in the arts and sciences disciplines. Table 7.2 displays recent data on graduate degrees awarded, by field and gender. Of the 359 000 graduate degrees granted in a typical year, approximately 322 000 are master's degrees and 37 000 are doctorates, for a ratio of ten master's degrees

Table 7.2. **Graduate degrees awarded by field**

	Master's				
	Total	Men	%	Women	%
All fields	321 992	152 907	**47**	169 085	**53**
Education	86 057	20 834	**24**	65 223	**76**
Engineering	24 848	21 429	**86**	3 419	**14**
Humanities and arts	19 090	7 673	**40**	11 417	**60**
Life sciences	28 588	9 156	**32**	19 432	**68**
Physical sciences	18 767	13 181	**70**	5 586	**30**
Social sciences	21 848	10 406	**48**	11 442	**52**
Professional/other	122 794	70 228	**57**	52 566	**43**
	Doctorate				
	Total	Men	%	Women	%
All fields	37 451	23 686	**63**	13 765	**37**
Education	6 397	2 679	**42**	3 718	**58**
Engineering	5 212	4 760	**91**	452	**9**
Humanities and arts	4 094	2 190	**53**	1 904	**47**
Life sciences	6 928	4 254	**61**	2 674	**39**
Physical sciences	6 276	5 122	**82**	1 154	**18**
Social sciences	6 127	3 101	**51**	3 026	**49**
Professional/other	2 417	1 580	**65**	837	**35**

Source: Master's degrees: National Center for Education Statistics, 1992. Doctoral degrees: Ries and Thurgood, 1993.

per doctorate. Because of the preponderance of master's study in graduate education, statistics for master's-degree students tend to dominate statistics for graduate students.

As for graduate enrolment, professional fields and education are the two largest fields for master's degrees, followed by the life sciences and engineering. At the doctoral level, the life sciences and education retain their positions as leading fields, but professional fields become the smallest of the major doctoral fields. Traditional arts and sciences fields are considerably more important for doctoral study, especially the physical sciences, social sciences, and humanities.

Accompanying the increase in graduate enrolment has been a parallel growth in the number of doctoral degrees granted by US universities. Table 7.3 provides details on the distribution of doctoral degrees across fields and trends over the last decade. From 1981 to 1986, the number of doctoral degrees granted grew by just 500 degrees from 31 357 to 31 895. Beginning in 1986, however, the number of new doctorates increased markedly, rising to 37 451 degrees in 1991, a record number for US institutions.

That overall growth was not uniform across major fields. For example, education, one of the largest doctoral fields in the United States, experienced a decrease in doctorates granted, from 6 645 in 1986 to 6 397 in 1991. The most rapid growth occurred in the natural sciences and engineering. The number of doctorates granted in engineering more

Table 7.3. **Doctorate degrees awarded by field, 1981-91**

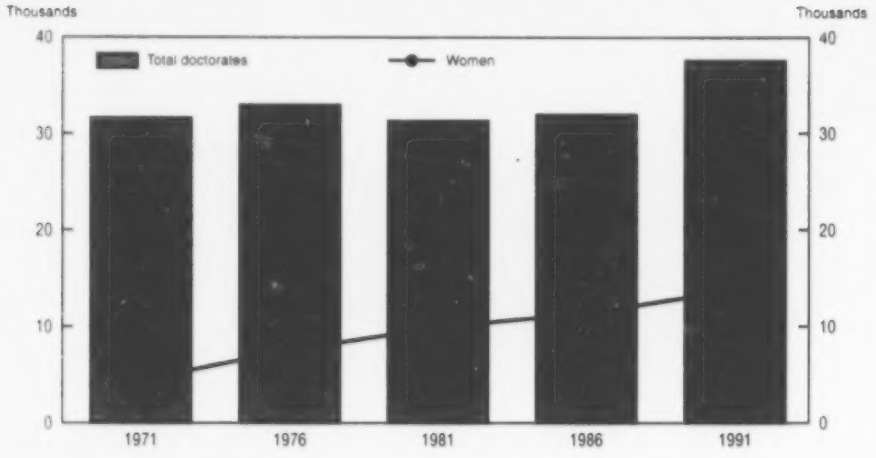
	1981	1986	1991
All fields	31 357	31 895	37 451
Education	7 497	6 645	6 397
Engineering	2 528	3 376	5 212
Humanities and arts	3 751	3 460	4 094
History	692	563	658
Amer. and Engl. lang. and lit.	820	719	853
Foreign lang. and lit.	576	445	498
Other humanities	1 663	1 733	2 085
Life sciences	5 611	5 733	6 928
Biological sciences	3 804	3 807	4 642
Health sciences	657	770	1 049
Agricultural sciences	1 150	1 156	1 237
Physical sciences	4 170	4 807	6 276
Physics/astronomy	1 015	1 187	1 408
Chemistry	1 612	1 903	2 194
Earth, atmosphere and marine science	583	589	837
Mathematics	728	729	1 040
Computer sciences	232	399	797
Social sciences	6 142	5 892	6 127
Psychology	3 358	3 124	3 240
Anthropology and sociology	974	872	806
Economics	825	860	877
Political science and international relations	532	490	522
Other social sciences	453	546	682
Professional/other	1 658	1 982	2 417
Business and management	624	902	1 164
Other professional fields	1 034	1 080	1 253

Source: Ries and Thurgood, 1993.

than doubled during the decade, and in the physical sciences it increased by 51 per cent. Among the science fields, gains in the number of doctorates occurred in the life sciences, while numbers in the social sciences dipped in mid-decade and recovered to 1986 levels by 1991. One of the most welcome trends was the increase in doctorates in the humanities, which followed a steady decline that began in the mid-1970s.

As shown in Figure 7.2, the number of women enrolled in graduate programmes and subsequently earning the doctorate has increased steadily since 1961. During the last three decades, in conjunction with social changes in the United States, many more women have begun to attend graduate school in preparation for careers in research and teaching. The number of women doctorate recipients rose from 1 128 in 1961 to 13 765 in 1991, or, as a proportion of all doctorates granted, from 11 per cent to 37 per cent. As Table 7.2 indicates, women are concentrated in the fields of education, social sciences, and humanities, and are less present in engineering and the physical sciences. Many universities have

Figure 7.2. **Doctoral degrees awarded by gender, 1971-91**



Source: Ries and Thurgood, 1993

active recruitment programmes designed to encourage more women to enter PhD programmes, especially in science and engineering fields.

There are notable differences in the distribution of women in master's and doctoral study. In 1990, 53 per cent of the master's degrees were earned by women. Education and the life sciences were the leading fields for women, with more than three-quarters of the master's degrees in education and two-thirds of the degrees in the life sciences earned by women. In fact, women constituted the majority of the master's degree recipients in all but three fields – engineering, the physical sciences, and professional fields. At the doctoral level, however, there is a reversal in the relative numbers of men and women. In 1991, men earned 63 per cent of all doctorates and had their greatest shares in engineering and the physical sciences. Women earned 58 per cent of the doctoral degrees in education and nearly half of the degrees in the humanities and social sciences. One of the factors contributing to the high percentage of men at the doctoral level is the number of foreign students earning doctoral degrees at US universities. Approximately 80 per cent of all foreign doctorate recipients are male. If only US citizen doctorate recipients are considered, the gender distribution changes from 63 per cent men and 37 per cent women to 56 per cent men and 44 per cent women.

Along with women, two other groups of doctorate recipients have been the subject of special interest at US universities – members of US minority groups and foreign students. A major problem in America has been the low numbers of US citizen minority students – individuals holding US citizenship or permanent resident status and belonging

Table 7.4. **Doctorates awarded by ethnicity, 1991**

(US citizens and permanent residents only)

	Number	Percentage of US doctorates
Total[1] US citizens and permanent residents	26 535	100
American Indian	130	< 1
Asian	1 491	6
Black	1 082	4
Hispanic	843	3
White	22 604	85

1. Includes other and unknown ethnicity.

Source: Ries and Thurgood, 1993.

to one of the following groups: American Indian, Asian, Black, or Hispanic – who participate in doctoral education. As shown in Table 7.4, minority doctorate recipients accounted for roughly 13 per cent of the PhDs granted to US citizens and permanent residents in 1991. Asians, Hispanics, and Blacks are the three principal minority groups at the doctoral level. Despite their low numbers, all groups showed a positive growth trend from the mid-1980s. Since 1986, the numbers of American Indians earning doctorates has increased from 99 to 130, or by 31 per cent, Asians from 1 058 to 1 491 or by 41 per cent, Blacks from 949 to 1 082 or by 14 per cent, and Hispanics from 478 to 843 or by 24 per cent.

Increasing minority participation in all phases of American life is viewed as one of the most important issues facing the United States today. Many universities are actively seeking minority students interested in pursuing advanced study, particularly at the PhD level. There is also a concerted effort to make graduate study more hospitable and negotiable for students with handicaps. In some cases, this means providing specialised facilities for students in wheelchairs or for those with hearing or vision impairments.

Currently, foreign students constitute 14 per cent of graduate enrolment at US universities and 24 per cent of doctoral degrees granted. In contrast to US citizens – who enrol in a wide variety of graduate programmes and institutions – international students tend to focus their study in science and engineering fields at research-oriented universities. As shown in Table 7.5, foreign students are concentrated in engineering, the physical sciences, and the life sciences. In fact, those three fields accounted for 72 per cent of all international doctorate recipients. In contrast, 41 per cent of US citizen doctorate recipients earned their degrees in these areas.

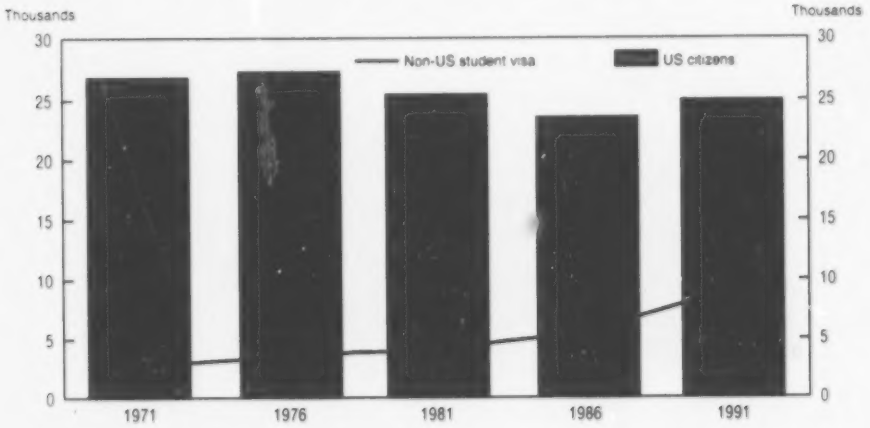
There is also concentration with respect to country of origin, with the largest numbers of students coming from Asian countries. In 1991, the three top countries of origin for non-US citizen doctorate recipients were the People's Republic of China, Korea, and Taiwan.

Table 7.5. **Doctorates awarded to international students at US institutions, 1991**

	Number	Percentage of total doctorates
All fields	8 852	24
Education	483	8
Engineering	2 473	47
Humanities and arts	510	13
Life sciences	1 686	24
Physical sciences	2 211	35
Social sciences	961	16
Professional/other	528	22

Source: Ries and Thurgood, 1993

Figure 7.3. **Doctoral degrees awarded by nationality, 1971-91**



Source: Ries and Thurgood, 1993.

The number of foreign students engaged in graduate work in the United States has been increasing steadily over the past 20 years (see Figure 7.3), and this has coincided with an apparent decline of interest, particularly in mathematics and engineering, on the part of American students. This has raised a number of concerns about the role of foreign students, faculty, and scientists and engineers in the United States. This issue is of interest not just in universities, but in the political arena as well.

The current organisation and content of research training

General aspects

Most research training in the United States takes place as an integral part of graduate education at the doctoral level. The organisation and administration of doctoral education is usually a shared responsibility involving three administrative units: the department, the college, and the graduate school. For example, a department of chemistry is an administrative unit within a college, usually a college of arts and sciences. Resources (*e.g.* space, salaries, library, equipment) come to the department as part of the college budget. Department heads make budget requests to their college dean who, after discussing and negotiating these budgets with all departments in the college, presents a budget request from the college to the central administration of the university. These requests deal with the total operating and personnel needs of the college and can include components of undergraduate, graduate, and professional education. Different colleges and departments may place different emphasis on these aspects of the budget. In research-intensive universities, the research needs of graduate students and faculty are given high priority at all levels – department, college, and central university.

Graduate deans become involved in this process in a number of ways, often working closely with department heads and college deans in preparing budget requests designed to improve graduate programmes. In addition, many graduate schools have, as part of their budgets, fellowship funds, which are distributed to all units, usually through competitive programmes based on student merit, and research support funds, which are used to provide grants for exploratory research, for the initiation of new collaborative research projects, and for other similar activities.

Programme design and requirement also are a shared responsibility. As mentioned before, a graduate school usually establishes a variety of requirements that apply to all departments. These may include a level of undergraduate academic performance considered acceptable for admission to graduate school, the minimum number of credit hours for which a student must register, a general examination that all students must pass in order to be admitted to candidacy for the PhD, and a doctoral dissertation demonstrating the student's ability to do independent, original research. These four types of requirement are very general and apply to virtually all PhD programmes in the United States. Within this framework, department faculty decide on the specific admission criteria for their programme, the amount of formal course work, seminars, and individual study required, the content and nature of the general examination, and the level and kind of research appropriate for doctoral dissertation topics. A group of the department faculty (the student's advisor and committee) pass final judgment on whether the quality of the research meets the research requirement for the PhD degree. The department and the faculty advisor, rather than the discipline, determine the specific details. It is not correct to assume, for example, that all chemistry departments will do things in the same way. Different departments of chemistry may vary within broad limits with regard to the number and kinds of courses required, the general examination, and other degree requirements. In fact, individual faculty advisors may also differ – within broad limits set by the

department – with respect to the requirements they impose upon their students. Some of the specific aspects of doctoral programmes will now be described.

Specific aspects

Admission

Admission to graduate programmes is competitive, based on faculty evaluation of a student's academic records, standardised test scores, letters of recommendation, and potential for research. Departmental faculty committees make recommendations for admission, usually to a graduate school, which acts as the official administrative unit for admission of graduate students.

Many departments actively recruit graduate students in a variety of ways ranging from publication of brochures describing the department's research interests, to visits by faculty to other institutions for the purpose of talking with potential graduate students.

Financial support

Most doctoral students in the United States require some form of financial support in order to pay tuition and have enough money for living expenses while attending school. As Table 7.6 makes clear, students use a wide variety of sources to finance their doctorates. The majority (67 per cent) of 1991 doctorate recipients indicated using their own or family funds. Many recipients also indicated personal resources through loans. Nearly half of 1991 recipients, particularly in those disciplines where there is a sufficient base of research and/or large undergraduate classes to be taught, received financial

Table 7.6. **Sources of support in graduate school, 1991 doctorate recipients**

	Per cent of doctorate recipients
Self/family sources	67
University teaching assistantship	46
University research assistantship	46
Other university	22
Federally-guaranteed loans	21
Other federal	9
Other loans	8
Business/employer	6
National non-federal fellowship	5

Note: In this table, a recipient counts once in each source category from which he or she received support. Since students indicate multiple sources of support, the vertical percentages sum to more than 100 per cent.

Because federal support obtained through the university cannot always be determined no distinction is made between federal and university research assistants in this table.

Source: Ries and Thurgood, 1993.

support through teaching or research assistantships. Assistantships, as well as fellowships and traineeships, are usually allocated on a competitive basis related to merit, not to financial need. A brief description of these four kinds of support is provided here.

Teaching assistantships (TAs). Universities may provide funds to pay graduate students for part-time teaching of undergraduate students. These funds are usually controlled at the department level, although in some institutions control resides in the graduate school. Students receive a stipend and may also receive a partial or total tuition scholarship. Teaching assistantships are available most often in disciplines where there are large undergraduate classes to be taught, such as chemistry, physics, mathematics, economics, humanities, and psychology. The teaching assistantship is a major form of support for doctoral students and, in addition, provides an opportunity for them to gain teaching experience. Teaching assistantships also provide a socialising factor that can be important, particularly in fields such as the humanities where graduate students tend to work alone. Some studies have indicated that, in these cases, students supported as TAs have higher PhD completion rates than those supported on fellowships. Currently, there is a great deal of interest in training TAs for their activities as teachers and preparing them to be faculty members. Several national conferences have been held on these and related topics.

Research assistantships (RAs). The majority of research assistantships are provided through grants and contracts obtained by faculty members, usually through competitive programmes of the federal government (*e.g.* NSF, NIH). Faculty members have full control over these funds and allocate them to students working under their direction whose interests coincide with the specific research project being funded. These assistantships are available primarily in the sciences and engineering. They provide students with stipends and funds to pay tuition. While students supported in this way are being paid in exchange for services, those services are usually directly related to their doctoral research. Research assistantships are seen as a highly desirable form of support since they require no work in addition to what the student would do for the dissertation and, in addition, assure close contact with the research advisor.

Fellowships. Fellowships may be available in any field and from a variety of sources. The federal government currently maintains fellowship programmes in the sciences as well as a small programme in the humanities. Many universities provide fellowship support from their own funds or from funds solicited from private donors who may have an interest in a specific area of research and who desire to provide support for a student in that area. Fellowships provide stipends and tuition support and require no services in return except that the student be enrolled full-time in graduate study and remain in good academic standing. Fellowships are highly competitive and awardees are usually chosen by faculty committees.

Traineeships. This is a form of support, usually provided through federal funds, in which universities compete for funds to support students in a certain area of research. Funds are provided, in the form of a training grant, to selected graduate programmes, and the faculty in those programmes assign traineeships to students, again on a competitive basis. These traineeships provide stipends and tuition.

The support of graduate students is a major concern in any doctoral programme. While it is true that students compete for admission to graduate schools, graduate programmes also compete for good students, who often apply to several different institutions of similar scope and quality. Students who have been offered admission by several programmes are strongly influenced in their choice by the availability and magnitude of support.

Programmes of study

The programmes of study of doctoral students, even within a single discipline, show great variety. The faculty of the department, and particularly the student's advisor, are the principal forces in determining a given student's programme. In some departments, the faculty have developed a core of courses that must be followed by all students and which are augmented on the basis of the student's specific interests. Each advisor may require a certain group of courses that exceeds the department's requirements. Again, in some departments, each student's programme is defined as a result of discussion between student and advisor. In all cases, the purpose is to ensure that the student has a firm grasp of the principles and theory in the field, can read the scholarly literature, and can embark on independent research. For most students, this stage is reached after two to three years of graduate study involving course work, seminars, and independent study. Students must then prepare to take the general examination for admission to candidacy for the PhD. This examination is prepared by several members of the faculty and is taken when both student and advisor believe that the student has a comprehensive knowledge of the field and the ability to use that knowledge critically, analytically, and creatively.

Research

All students working on the PhD degree must perform research. While a small number of students enter graduate school with a specific project in mind, the vast majority enter because of an interest in the field of study and, perhaps, in the research specialties and sub-divisions of a given faculty. In these cases, the choice of a doctoral research project is a matter of negotiation between student and advisor, with the advisor playing an important role in helping the student define a project of sufficient substance to qualify for the PhD, but also one that has a good chance of being completed within a reasonable period of time (usually two to three years of full-time research). The combination of the formal part of the programme (course work) and the research part means a total of four to six years of full-time study for the PhD. Actual time-to-degree figures are higher than this and vary considerably by field (see Table 7.12).

In the sciences, students often begin working on their research projects during their first year in graduate school. This is primarily because many students work on grants obtained by their advisors, rather than initiate their own research projects. In addition, most science students have learned many of the technical aspects of their field as undergraduates, and so can begin working in a laboratory soon after entering graduate school. In the humanities, students are much more likely to develop their own dissertation topics and to begin research much later, often once they have passed the general examination. Graduate students in the humanities rarely work directly with their advisors on a

specific project; they are more likely to choose a project within the general sphere of competence and interest of a faculty member and then proceed alone, with advice and counsel, rather than as a collaborator. Students in the humanities also are usually responsible for finding funds to support their research, whereas in the sciences, faculty advisors bear major responsibility for providing support for their student's research. This includes support for the actual research and often support for the student through research assistantships.

In some disciplines, research methodology and techniques are taught informally, with senior graduate students, postdoctoral research associates, and advisors teaching students individually the specialised skills associated with the kind of work being done. This is particularly true in the laboratory sciences. In other cases, certain general skills, such as statistics, or even advanced research techniques, may be taught through formal courses. In all cases, however, the majority of research training takes place by performing research with the guidance of experienced colleagues.

The doctoral dissertation

In 1991 the Council of Graduate Schools published the results of a study on the role and nature of the doctoral dissertation in 50 universities. This study explored the views of faculty, students, and administrators on the current state of the dissertation. There was general agreement in all disciplines that the objective of the dissertation was two-fold: to demonstrate that the student could do independent research of a quality deemed acceptable for the PhD and to make a significant contribution to knowledge. There were, however, considerable differences of opinion and practice among disciplines with respect to how that objective is achieved. For example, in many science fields students publish short papers while they are working on their doctoral research projects. It has become common practice for the content of these papers to form part, if not all, of the doctoral dissertation. In the humanities this is almost never the case, and some humanists object to the idea of using previously-published material as part of the dissertation. It is also not unusual for graduate students in some science fields to work in groups on large-scale research projects. Students in these groups are expected to be able to clearly demonstrate their individual contribution to the work.

There has been considerable comment from scientists that research, done as part of doctoral study, should be carried out as it is by practicing research scientists. In other words, students must learn to work in groups and collaborate with others on research projects. This applies within disciplines as well as for projects involving students and faculty members from a number of different disciplines. Indeed, interdisciplinary research, particularly between biological scientists, physical scientists, and engineers, occurs routinely, and graduate students use results from these group projects in their dissertations.

The prevalent view in the sciences is that doctoral research is primarily training and that the dissertation should be viewed as the beginning rather than the culmination of a student's scholarly career. Some humanists dispute this view.

Almost all institutions require students to defend their dissertations, at least before their committees, and often in a more public setting. This dissertation defence is viewed

by many as a formality, and in some universities it has been abandoned. Others, however, have taken the position that it is more important than ever, particularly in projects involving research groups.

International considerations

There are two broad types of international activities at the graduate level. The first is movement of students and/or faculty from one country to another as individuals; the second is formal programmes, either through organisations involved in international educational exchange or through university-to-university agreements. Regarding the first type, relatively few American graduate students take advanced research degrees in other countries. A somewhat larger group may spend some part of their doctoral programme in another country, usually to obtain access to specialised material available only in that country or to work for a short time in a particular laboratory to learn a technique or method that has been developed there. The situation for students from other countries is quite different; they come to the United States in large numbers (approximately 200 000 in 1992) to study for advanced degrees. In some fields, such as physics, astronomy, and mathematics, the research community is truly international, with scientists from many countries routinely working as collaborators. The focus for many of these activities may be a specialised research facility, *e.g.* an accelerator or an astronomical observatory, where scientists gather to use the facility in their research.

With respect to the second type of international activity, an increasing number of American universities appear to be interested in institutional agreements based on mutual research interests in specific areas of research. In these agreements, faculty and graduate students from one institution often spend (usually short) periods of time in the other in order to acquire techniques and discuss problems with colleagues. The institutional agreements also deal with issues of housing, access to materials, health care, and other administrative concerns that can impede such programmes if not dealt with properly and in advance. These agreements are often developed and negotiated by graduate deans.

Postdoctoral research associates (postdocs)

In some fields, particularly chemistry, physics, and the biological sciences, it has become almost standard practice for students to do several years of postdoctoral research after completing the PhD. These students usually are supported either by research grants obtained by faculty or through competitive fellowship programmes that may be funded either by the federal government or by the universities themselves. Occasionally, postdocs may remain in the institution where they obtained the PhD, sometimes continuing on the same project. Much more often, however, students go to a different institution or institutions for postdoctoral experience, often to obtain training in specialised techniques or to broaden their experience by doing research in an area different from, but related to, their doctoral work. For example, an organic chemist might seek a postdoctoral appointment with a biochemist in order to learn how to work with enzymes that might be useful in carrying out chemical reactions.

Table 7.7. **Science and engineering postdoctoral appointees in doctoral-granting institutions, 1983-91**

	1983	1987	1991
All fields	20 719	24 831	31 553
Engineering	1 101	1 441	2 237
Life sciences	13 724	16 858	21 757
Physical sciences	5 111	5 701	6 631
Social sciences	783	831	928

Source: National Science Foundation, 1992

Postdocs play an important role in the informal teaching of graduate students since, in the fields involved, research groups formed around a professor or several professors are commonplace. For example, physical scientists and/or engineers may form working research relationships with biologists in bioengineering. Postdocs with a variety of backgrounds, as well as graduate students from a variety of disciplines, may work together on research projects in this area. Postdocs are likely to have more day-to-day contact than professors with graduate students, and thus serve as teachers as well as colleagues.

Table 7.7 provides current information on the number and distribution of postdocs in the United States, by discipline. In 1991, there were 31 553 individuals holding postdoctoral appointments in science and engineering fields, with nearly 70 per cent of the postdocs in the life sciences. The number of postdocs has grown steadily from 1983 to 1991, increasing by 52 per cent over the eight-year period.

Involvement of non-university organisations in research training

The federal government maintains a number of national laboratories and research facilities. Among the best known are the National Institutes of Health, for research in the biomedical sciences, and Fermi Lab, Argonne, and Oak Ridge, among others, devoted primarily to physics, mathematics, chemistry, and engineering. These laboratories provide opportunities for graduate students, postdocs, and faculty members in the relevant areas to spend periods of time ranging from several weeks to several years working in association with government scientists. Many universities have specific collaborative arrangements with these laboratories whereby students can do all or part of their dissertation research in them, under the co-direction of a university faculty member and a scientist at the facility. In certain fields, such as high energy physics, this is a significant component of research training.

A very different relationship exists between certain departments and various research-intensive companies. The general term for this relationship is an "industrial associates programme". In this kind of programme, a company with specific interest in the research conducted in a particular department may form a relationship with that

department involving provision of general research support and, occasionally, fellowship support for graduate students. In exchange, scientists from the company may visit the department during the year for seminars and meetings about shared research interests. The companies are interested in learning about the department's research and in identifying graduate students for possible future employment. This is quite different from the usual form of industrial support of research through grants or, more often, contracts to support a specific research project or programme.

Research training and the labour market

The diversity of career paths followed by doctorate recipients in the United States reflects the variety of doctoral programmes. Tables 7.8 to 7.10 contain data on the employment of doctorate recipients in the US labour market. The first two tables are derived from the Survey of Earned Doctorates Summary Report and provide statistics on the immediate post-graduation plans of doctorate recipients. A second data source – the Survey of Doctorate Recipients (Table 7.10) – is a study of doctoral degree holders in the US labour force and provides information on the actual career paths followed by recipients.

Shown in Table 7.8 are data on the plans of new PhDs, divided into two general post-graduation activities – postdoctoral study or employment. It is important to note that these two activities can take place in many settings, for example, postdoctoral study appointments are available at universities, federal laboratories, private medical centres, etc. Nevertheless, post-graduation employment was by far the dominant activity for 1991 PhDs and concerned 73 per cent of new doctorate recipients. However, in science fields – particularly the life and physical sciences – more than half of the students had commitments for postdoctoral study. As previously mentioned, postdoctoral study in these fields is a natural step on the path towards an academic research career. In other

Table 7.8. **Postgraduation activity doctorate recipients, 1971 and 1991**

	Total		Study (%)		Employment (%)	
	1971	1991	1971	1991	1971	1991
All fields	23 867	24 082	16	28	84	73
Education	4 896	4 408	2	4	98	96
Engineering	2 430	2 855	10	21	90	79
Humanities and arts	3 543	2 440	3	7	98	93
Life sciences	3 885	4 764	40	62	60	38
Physical sciences	4 179	4 036	36	49	65	52
Social sciences	4 099	3 876	8	17	92	83
Professional/other	835	1 703	1	3	99	97

Note: Only doctorates with definite commitments are included. Percentages are based on the number of PhDs with known post-graduation plans.
Source: Ries and Thurgood, 1993.

science fields – such as engineering and the social sciences – most new doctorates move directly into employment either in higher education or in other sectors. Postdoctoral study is rare in non-science fields – in education, the humanities, and professional fields. Graduates in these fields typically move directly into employment after they have received the doctorate.

Table 7.8 also displays data on the trend in post-graduation activities from 1971 to 1991. Over the last two decades, there has been a general increase in the percentage of students planning postdoctoral study, from 16 per cent of the cohort of new doctorates in 1971 to 28 per cent in 1991. This trend has been especially pronounced in engineering, the life sciences, and the physical sciences. There are two main reasons for the shift towards postdoctoral study. First, US immigration law allows foreign students to remain in the United States to pursue further study for one year following receipt of the doctorate. As the number of non-US citizens earning doctorates increased, so too did the number of international students planning a year of postdoctoral study in the United States. Second, over the last 15 years a postdoc has become virtually a required step for gaining academic employment, especially in the life sciences and the physical sciences.

For those new PhDs planning employment, the Survey of Earned Doctorates requests information on the planned employment sector. The figures in Table 7.9 point to the wide range of careers they expect to pursue. Slightly more than half of the 1991 doctorate recipients planned to move directly into the higher education sector, with 19 per cent planning employment in industry, 10 per cent in government, and 19 per cent in

Table 7.9. **Employment sector for doctorate recipients[1] with post-graduation employment commitments in the United States**

(US citizens and permanent residents)
Percentage

	Academy		Industry/self employment		Government		Others[2]	
	1971	1991	1971	1991	1971	1991	1971	1991
All fields	69	53	12	19	11	10	9	19
Education	68	47	1	6	8	7	23	41
Engineering	31	26	47	57	20	15	3	2
Humanities and arts	94	84	1	4	1	3	4	10
Life sciences	69	52	11	24	17	16	3	8
Physical sciences	54	36	30	49	12	12	3	3
Social sciences	76	50	4	18	13	14	8	18
Professional/other	81	75	7	8	9	4	2	13

1. Only doctorates with definite commitments for employment are included. Foreign locations are excluded. Percentages are based on the number of PhDs with known employment sector. In 1991, 76 per cent of the new US citizen doctorate recipients and 70 per cent of the new permanent resident doctorate recipients reported definite commitments for employment.
2. Includes primary and secondary schools, and non-profit organisations.

Source: Ries and Thurgood, 1993.

other settings such as the non-profit sector or elementary/secondary education. While the overall figures indicate that an academic career is the most common objective, it is the choice of less than half of the doctorates in education, engineering, and the physical sciences.

In addition, the percentage of new PhDs planning academic employment has declined from 69 per cent in 1971 to 53 per cent in 1991. The percentage of doctorates increased in two sectors – private industry and other (elementary and secondary schools and non-profit institutions). Nearly three-fifths of the PhDs in engineering and half of those in the physical sciences chose employment in private industry. On the other hand, fully 84 per cent of degree recipients in the humanities and one-half of the doctorates in the life sciences planned academic careers, but both of these major fields saw a decrease in this goal over the 20-year period.

The post-graduation plans of doctorate recipients are reflected fairly directly in the eventual employment in the labour force. Table 7.10 presents statistics on employment of individuals who earned doctorates between 1946 and 1988 and were employed in the US labour force in 1989. As noted earlier, PhDs are employed throughout the American economy, in educational institutions, private industry, government, and the non-profit sector. Not surprisingly, the principal employment sector for humanists is the academic institution, which employs 81 per cent of humanities PhDs. For PhDs in other fields the situation is considerably more varied. More than half of all engineers are employed in business/industry and 34 per cent in educational institutions. Physical scientists are about evenly split between the education sector and business. For PhDs in the life sciences and social sciences, about three-fifths are employed in educational institutions and one-fifth in business/industry. The salient point here is the range of employment opportunities for doctorate recipients in the US economy. Moreover, the trend is towards a greater variety of employment settings and away from the traditional academic career.

Finally, it is crucial to point out that employment in higher education does not necessarily mean employment as a college or university faculty member. In fact,

Table 7.10. **Employment sector of individuals holding doctoral degrees, 1989**

Field of doctorate [1]	Total employed	Educational institution [2]	Business/ industry	Government	Non-profit
Engineering	74 783	34	56	7	3
Humanities and arts	88 400	81	10	4	5
Life sciences	115 833	61	20	10	7
Physical sciences	127 404	46	41	9	3
Social sciences	130 623	58	21	9	11

Notes: Totals represent those individuals holding doctorates granted between January 1946 and June 1988. Includes both full-time and part-time employment.

1. This survey does not include the fields of education or professional/other.
2. Includes elementary and secondary schools as well as higher education institutions.

Source: Brown and Pasquini, 1991, and National Science Foundation, 1991.

academic institutions – especially research institutions – offer a variety of non-faculty career tracks for doctorate recipients. During the past 15 years, perhaps the fastest-growing such employer has been the "organised research unit" or ORU. ORUs have been established on many campuses as centres for research in a specific area, many in medical fields. These ORUs typically employ research scientists who are not members of the university faculty. Moreover, these ORUs are also the home for many doctorate recipients on postdoctoral appointments. One of the issues facing research universities today is the relationship between these independent research units and the educational mission of the institution.

Issues and concerns in research training

As described in the foregoing sections, research training in the United States involves thousands of students and hundreds of institutions, and is generally viewed, both at home and abroad, as being of high quality. It is a highly-differentiated system in terms of institutions, with most doctoral education, particularly in the arts and sciences and engineering, occurring in a group of approximately 150 institutions that serve as models to other institutions developing doctoral programmes. Because of the structured nature of American graduate education, it is possible to discuss, in general terms, issues affecting all graduate programmes, as well as to focus attention on particular disciplines.

General issues

Quality

There is ongoing concern about the quality of doctoral education and how to measure it. Over the years, several studies have been carried out to try to assess the quality of doctoral programmes in specific disciplines. The latest of these was the *Assessment of Research Doctorate Programmes in the United States*, carried out by the Conference Board of Associated Research Councils and published in 1982. Like its predecessors (Roose and Anderson, 1970; Canter, 1966), it focused attention on peer perceptions of the scholarly achievements of the faculty in specific programmes. Thus, historians were asked their opinions about other historians, mathematicians about other mathematicians, and so on. Regardless of what other data were collected (*e.g.* publications, research funding, programme size), the general view has been that the scholarly quality of the faculty was the best indicator of the quality of the doctoral programme.

There are many flaws in studies of this type. For one thing, it is recognised that the scholarly achievements of the faculty do not guarantee a good doctoral programme, and some new approaches are now being considered for a forthcoming (1993-94) assessment that will take other factors into account. Suffice it to say, however, that there is continuing interest in the academic community and in the public press about the rankings of graduate programmes. This interest usually intensifies with the publication of new studies. These rankings have no official status, and there is no direct linkage between them and the allocation of research funds by sponsors.

Research and teaching

American research universities are based on the premise that research and teaching reinforce each other and that faculty members should be actively involved in both. Over the years, however, critics have complained that the research activities of the faculty are considered to be more important than teaching in the institutional and professional reward systems, and that intensive research activity can detract from, rather than enhance, undergraduate instruction. There is currently extensive discussion of this issue in the context of widespread dissatisfaction with the quality of undergraduate education. A particular focus is the role of doctoral education in preparing people to be faculty members and to teach, and many institutions have developed programmes at the department as well as at the university level to introduce graduate students to the issues and techniques associated with university teaching. Closely related is concern that faculty members may seek to avoid teaching in order to concentrate their efforts on research, and some institutions are trying to find a more appropriate balance between these two important activities.

Two recent publications capture the flavour of this discussion. The first, *America's Academic Future* (Directorate for Education and Human Resources, 1992), is the report of a symposium that brought together a group of exceptional young academic scientists who had been designated Presidential Young Investigators in a highly competitive National Science Foundation programme. These were among the country's brightest young scientists, and they met to discuss the future of universities. All their recommendations related to the need to improve teaching – the teaching of undergraduates, the preparation of school teachers, the general education of the public in scientific matters, and the preparation of college faculty. These recommendations had been made before, but, coming from this group, the report had particular impact.

The second publication is a book called *Scholarship Reconsidered: Priorities of the Professoriate*, by Ernest L. Boyer (1990). In this book, Boyer describes several different types of scholarship: the scholarship of discovery; the scholarship of integration; the scholarship of application; the scholarship of teaching. He points out that the reward systems of universities tend to place most, if not all, value on the scholarship of discovery, and argues that all are needed for a strong and vital university system. In addition, he suggests that faculty members may concentrate on different kinds of scholarship at different points in their careers, and that different kinds of universities may emphasise one kind over others. This book supports the view that the argument is not really between teaching and research; it is between scholarly teaching and non-scholarly teaching, and there is no excuse for non-scholarly teaching.

Universities across the country are grappling with these issues as they attempt to fulfil the difficult role assigned to them by society – to teach students, to prepare people for careers, to produce the next generation of teachers and faculty members, to assist in economic development, to train scientists and scholars, and to generate basic knowledge through research. The major challenge is to realise the potential of the research university as a place where the research and teaching activities of the faculty are truly synergistic and where everyone learns in an atmosphere of inquiry.

Integrity in scholarship

Over the past ten to 15 years, a number of cases of misconduct in research have received widespread public attention. These cases have primarily involved plagiarism and falsification of research results. There has been general concern that this problem may be more widespread than heretofore realised, although this may not be the case. Universities and federal agencies that fund research have developed procedures for investigating allegations of misconduct in research and, in addition, many universities have brought discussion of ethical issues and integrity in research into their graduate programmes. A number of publications have appeared which are designed to introduce graduate students to some of the issues involved. One of these, *On Being a Scientist*, a 1989 publication of the National Academy of Sciences, is widely used in orientation programmes for new graduate students.

Conflict of interest and commitment

An additional issue of concern is conflict of interest and/or commitment on the part of faculty. As universities and their faculties have become more interested in the possible commercial value of research ideas and discoveries, many have become directly involved in the formation of companies whose role is to develop and market products. Whether universities establish these companies or faculty members become involved as officers of independent companies, the possibility arises that commercial interests will conflict with the academic responsibilities of the institution as well as of its faculty. There have been several well-publicised cases of this kind, and federal agencies, businesses, and universities are trying to develop procedures that will protect all parties. Particularly vulnerable are graduate students whose dissertation research projects may be influenced by the commercial interests of their advisors.

Forecasting supply and demand of research personnel

In the United States, the labour market for highly trained researchers has been characterised by periods of high demand and undersupply followed by years of low demand and oversupply. One of the central elements of the R&D labour market is the length of time it takes to produce a new PhD, now averaging from six to ten years. Because of this long production lag, individuals attracted to graduate school during periods of high demand typically graduate at the end of the demand cycle, perpetuating the boom and bust cycle of the labour market. It is frequently asked whether the supply of, and demand for, researchers and scholars could not be better managed in order to smooth out the peaks and troughs of the supply/demand cycle.

As a first step, it would be necessary to accurately forecast the demand for trained researchers and then compare these estimates to a forecast of probable supply of research personnel. Then, government agencies could work with the universities, *via* incentives such as federal fellowship programmes, to better manage supply to meet demand. There is a history of efforts to forecast supply of, and demand for, researchers and scholars. Two recent projection efforts are the National Science Foundation's forecast of supply

and demand for scientists and engineers (used as a basis for Atkinson, 1990) and Bowen and Sosa's work (1989) on the academic labour market.

In the NSF model, demand was estimated to grow at a steady rate, with replacement of those retiring from the science and engineering labour force and growth in demand of approximately 4 per cent per year. Supply projections were based on demographic trends, using a "5 by 5 rule" based on historical trends: 5 per cent of the 22-year-old population obtained bachelor's degrees in science and engineering, and 5 per cent of that group would go on to earn the PhD. Thus, supply would rise and fall in line with the number of college-age individuals in the US population.

The combination of a projection of increasing demand and a declining number of 22-year-olds in the US population would result in what the NSF described as a serious shortfall in supply. However, the NSF model has two obvious flaws. First, the shortfall was considered to be cumulative, that is, the market would not clear in each hiring period, so that the shortfall in one year would increase that of the next. Second, there was no mechanism for feedback between the supply and demand equations to account for market responses to a shortage – for example, higher wages, restructuring of jobs to allow the hiring of non-PhDs, and the use of personnel already in the labour market as a substitute for new PhD recipients. In other words, the NSF model did not take into account the powerful equilibrating forces of the labour market, and is now considered to be a "worst-case scenario" model.

Bowen and Sosa, in *Prospects for Faculty in the Arts and Sciences* (1989), take a somewhat different approach to forecasting the future labour market for academic faculty. New doctorates are assumed to be the major source of hires for faculty positions, and the supply/demand situation is seen as a balance between demand for new faculty for replacement (retirement, departures, and death) and growth in the net number of new positions driven by changes in undergraduate and graduate enrolments. Bowen and Sosa see two sets of forces acting on the faculty labour market – replacement demand due to the retirement of the faculty hired in periods of rapid university growth in the 1960s, and growth demand from expansion in the number of undergraduates as the children of the baby-boom generation enter college.

According to the Bowen-Sosa model (see Table 7.11) the current excess supply of new doctorates for faculty positions is projected to continue through 1997. After 1997, however, the balance shifts rapidly from surplus to shortage in the humanities and social sciences and in mathematics and the physical sciences. Faculty shortages are expected to be greatest in the humanities and the social sciences, with an average of just 0.71 new doctorate recipients for each faculty opening.

Two assumptions of the Bowen-Sosa model have received particular attention. First, the authors held the student-faculty ratio constant at 1987 levels, or an average of 9.6 students per faculty member. However, these ratios have been much higher in other periods, and allowing the ratios to rise towards the higher levels of the 1970s would lessen the demand for new faculty. Second, all faculty hires are expected to be from each year's cohort of new PhDs. At the same time, the oversupply of the early 1990s would produce a reserve pool of PhDs not working at universities who could be hired to fill full-time positions. In addition, universities could increase their use of use part-time faculty to

Table 7.11. **Supply and demand projections for arts and sciences faculty, 1987-2012**

	1987-92	1992-97	1997-2002	2002-07	2007-12
Humanities/social sciences:					
Projected supply	14 335	13 633	13 460	13 460	13 460
Projected demand	10 536	11 758	18 935	19 452	16 795
Supply – demand	3 799	1 875	(5 475)	(5 992)	(3 335)
Supply/demand[1]	1.36	1.16	0.71	0.69	0.80
Mathematics/physical sciences:					
Projected supply	7 603	7 567	7 471	7 471	7 471
Projected demand	5 024	5 800	9 312	9 380	7 903
Supply – demand	2 579	1 767	(1 841)	(1 909)	(432)
Supply/demand[1]	1.51	1.30	0.80	0.80	0.95
Biological sciences/psychology:					
Projected supply	10 600	10 099	10 003	10 003	10 003
Projected demand	4 818	5 495	8 844	9 054	8 295
Supply – demand	5 782	4 604	1 159	949	1 708
Supply/demand[1]	2.20	1.84	1.13	1.10	1.21
All Arts/sciences:					
Projected supply	32 538	31 299	30 934	30 934	30 934
Projected demand	20 378	23 054	37 091	37 886	32 993
Supply – demand	12 160	8 245	(6 157)	(6 952)	(2 059)
Supply/demand[1]	1.60	1.36	0.83	0.82	0.94

1. The supply projection divided by the demand projection is the number of candidates per position.
Source: Bowen and Sosa, 1989.

handle the increased teaching loads. Thus, two university responses – increasing the student/faculty ratio and hiring part-time or older PhD recipients to fill faculty positions – could do much to decrease the shortages projected by Bowen and Sosa.

Finally, like all projection models, both of these models suffer from the inability to accurately forecast the demand side because of the tremendous influence of external economic events on demand for new hires. Projecting the PhD labour market is made more difficult because of the need to forecast six to ten years in advance. This is a nearly impossible task, given the recent history of economic recession and potentially deep cuts in federal spending, particularly in defence industries that employ many scientists and engineers. With all their faults, however, projection models are useful because they provide a sense of what the future would be like under a strict set of assumptions. However, they are inherently limited tools for policy-making because external economic forces inevitably upset these assumptions in unpredictable ways.

Programme issues

Several issues relating to the processes of doctoral education have been raised during the past few years. Among these are: time to degree, or the length of time required

to obtain the degree; completion rates, or the percentage of students who obtain the degree out of those who start; and the relationship between faculty advisor and graduate student. Each of these will be discussed briefly (for an excellent recent discussion of these and related topics, see Bowen and Rudenstine, 1992).

Time to degree

A database containing information on time to degree has been maintained for many years by the National Research Council. Data is presented in two ways: the total time that elapses between receipt of the bachelor's degree and receipt of the PhD and the registered time, *i.e.* the time during which the student is registered in graduate school. Some of these data are shown in Table 7.12. There are several problems with these data. Students often delay entering graduate school for some time after receiving the bachelor's degree, and different institutions often have different requirements for registration, so that some students may be working on the degree while not registered, and *vice versa*. Bowen and Rudenstine have suggested that a better way to present such data is to measure forward from the time a student first enrols in graduate school rather than backwards from the time the degree is obtained. In either case, time to degree has been increasing over the years, and many people believe it is too long. Some of the factors that enter into play are lack of adequate financial support, poor choice of dissertation topic, and inadequate supervision by the student's advisor. Concerted efforts are being made in many graduate programmes to reduce time to degree to four to five years of full-time study.

The data for all disciplines are distorted by the fact that in some disciplines, notably education, it is common practice for individuals to work full-time and pursue their graduate degrees on a part-time basis. Also, in the humanities, students may leave graduate school before completing the dissertation in order to take jobs. These students may then work on their dissertations on a part-time basis. In the sciences and engineering, the norm is for students to enrol full-time while working on the PhD. In part, this is

Table 7.12. **Median registered years to degree for doctorate recipients, 1981-91**

	1981	1986	1991
All fields	6.4	6.8	7.0
Education	7.0	7.8	8.1
Engineering	5.7	5.9	6.1
Humanities and arts	7.7	8.2	8.4
Life sciences	5.9	6.4	6.7
Physical sciences	5.7	6.0	6.3
Social sciences	6.5	7.2	7.5
Professional/other	6.5	7.3	7.5

Note: Medians are based on the number of individuals who have provided complete information about their postbaccalaureate education.
Source: Ries and Thurgood, 1993.

related to the need, in the sciences, for laboratories and special equipment. It also is related to the availability of support for research in these fields.

Completion rates

Data on completion rates have been difficult to obtain. The time period during which students must complete the PhD is set by most graduate schools at twelve years from entry but may be extended in individual cases. Thus, a student may drop out for several years and then reappear to complete the programme. Data on completion rates should start to be collected when students enter graduate school and students must be followed up to completion or non-completion. Bowen and Rudenstine, examining only six to eight universities in just a few disciplines, found that only about half of all entering students in many PhD programmes eventually obtain doctorates. While there are no national data on completion rates, the findings of Bowen and Rudenstine and other studies reflect a consistent pattern. Completion rates vary widely by field: the sciences and engineering have the highest rates (60 to 70 per cent), the social sciences are in the middle of the range (50 to 60 per cent), and humanities have the lowest rates (40 to 50 per cent).

There is a general concern that completion rates are too low and that, from that perspective, doctoral education is wasteful of financial and human resources. The issue of completion rates raises some difficult problems for educators. For one thing, graduate schools have been meritocratic and Darwinian. It has appeared to many that the role of the faculty has been less to help students finish their programme than to maintain a kind of "sink-or-swim" atmosphere where only the strongest survive. This attitude is being questioned. The admissions process is not perfect, and there are no indicators that guarantee success in graduate school. Certainly, factors such as excellent academic preparation, strong motivation and drive, creativity, and intellectual brilliance would lead admitting committees to offer admission, but many students with all of these attributes do not complete. On the other hand, students who seem less well suited to research may suddenly "catch fire" and do an excellent dissertation. In many cases, a good advisor can make the difference. Money is also a factor, and some students fail to complete mainly because they can no longer afford to continue.

As for time to degree, universities are seeking ways to improve their programmes so that a higher percentage of those who enter actually complete the degree.

Faculty-student interactions

During the last few years, there has been a great deal of interest in the relationship between graduate students and their advisors. The term "mentor" has been increasingly used to describe a relationship in which faculty would take an active interest in each student and, in addition to advising on course selection and research problems, would accept the responsibility of helping students complete their degrees. Recent criticism of faculty advisors has centred on their preoccupation with their own research and their lack of interest in students except as instruments through which faculty research can be accomplished. There is much anecdotal evidence of this, along with clear indications that many, if not most, faculty members take their role as advisor, and perhaps mentor, very seriously. Because the issue is felt to be vital, institutions and organisations concerned

with graduate education have made it a topic for discussion and have developed recommendations for improvements. These include seminars, workshops, recognition of outstanding graduate mentors, and programmes whereby senior faculty members with good records as mentors of graduate students provide the same service for their junior faculty colleagues.

New initiatives

During the past few years, discussions about the role of universities in contemporary American life have been taking place in universities, in public fora, in special commissions and committees, and in state and federal legislative bodies. Universities, particularly the large, publicly-supported institutions, now carry on a multitude of activities ranging from basic research to remedial education. The current recession has made it clear that there is not enough money to do everything. This has led universities and their patrons to seriously consider what they should do and what they can afford to do. Here, attention will focus on one aspect of the problem that is receiving considerable attention: the role that university research and research training plays in the overall research activities of the country.

In 1989 the Government-University-Industry Research Roundtable (GUIRR) published the first report in a series on academic research. Its title was *Science and Technology in the Academic Enterprise: Status, Trends, and Issues*. Among other things, it described the decade of the 1980s as one of great diversification and expansion of academic research, largely owing to increased public expectations for science and technology resulting from concerns about international competitiveness, on the one hand, and domestic economic development, on the other. The federal government, state governments, and private industry all sought greater interaction with universities in areas such as biotechnology and microelectronics. The term "technology transfer", meaning the commercialisation of research ideas, entered the vocabulary, and more universities began to develop research programmes in order to capitalise on this interest and gain additional funding and prestige. Many of these programmes involved the development of research groups devoted to some topic of current national or local interest. These programmes often did not involve either faculty or graduate students but were staffed primarily by postdoctoral research associates. Universities began to develop significant cadres of non-faculty researchers. State universities came under pressure to work more directly with local industry in order to provide assistance in research and development and often developed specific programmes for that purpose.

As this trend strengthened, several things became apparent. First, there was not enough money to fund a rapidly-expanding academic research community. Second, it was thought that spreading available resources over a larger group of institutions would dilute the overall research effort, particularly since increasing amounts of research support money were being allocated through political mechanisms. Third, it was feared that the nature of university research would be affected by the pressures to do more applied research and development and that this, in turn, would lead to less research training.

Finally, many worried that these research pressures would exacerbate what some viewed as a serious rift between teaching and research.

The committee report raised a number of broad questions for discussion in the academic community. Among them were:

- What is the optimal role for universities in the nation's overall research system?
- What is the appropriate role for universities to play in addressing national and regional priorities?
- What should be the research and education role of US universities in an increasingly international research environment?
- Does the US academic research enterprise have an optimal size, scope, and degree of diversity?
- Does the current balance between scientific research and education require re-examination?
- How can an adequate supply of qualified scholars be attracted to academic research?
- How should resources be allocated among competing national research objectives?

These and similar questions led to a series of reports that tried to deal with the basic issue: how can the United States make best use of its universities and, particularly, of academic research?

In 1990, GUIRR released a second report, *The Academic Research Enterprise within the Industrialized Nations: Comparative Perspectives*, and in 1992 published its final report, *Fateful Choices: The Future of the US Academic Research Enterprise*. Among other things, this report provided a matrix for policy-making for research universities, which considered the size of the system (larger, smaller, the same) and its structure (more concentrated, more dispersed, the same) in the context of the economic, political, scientific, and international climate. In addition, the report points to the need to ensure the research university's commitment to teaching at both the undergraduate and graduate level, as well as the need to improve the quality of pre-college education in the sciences and mathematics. This report is currently being discussed and debated.

Fateful Choices was followed by two other reports with revealing titles. One, from the President's Council of Advisors on Science and Technology, released in December 1992, is *Renewing the Promise: Research-Intensive Universities and the Nation*. The other, a companion volume, from the *Ad Hoc* Working Group on Research-Intensive Universities and the Federal Government, released at the same time, is *In the National Interest: The Federal Government and Research-Intensive Universities*.

The first report emphasises the need for concentration rather than continued expansion. In the words of the report, "The relentless quest for an ever-broader range of activities will inevitably destroy the most important aspect of American higher education and research – quality". The report also recognises the problem, particularly in research-intensive universities, of neglect of teaching, specifically undergraduate teaching, in favour of research, and reaffirms very strongly the importance of teaching and the involvement of senior faculty in teaching.

Other recommendations concern public trust, federal support of basic research, better linkages with industry, and an intensification of efforts to identify talented young people and involve them in advanced education and science.

The second report, which focuses on the relationship between the federal government and the research-intensive universities, echoes many of the recommendations. One important recommendation is that: "Federal agencies should examine the impact of federal research support on university undergraduate and graduate education and identify strategies to ensure against unintentional degradation of the educational mission and excellence of research-intensive universities"

Finally, a commission appointed to evaluate the mission of the National Science Foundation, particularly with respect to expansion of its activities with industry, strongly endorsed the NSF's current role in supporting academic research, science teaching, and the development of scientific personnel

In sum, all these reports and discussions make the point that universities perform their most important role in society by producing knowledge and by educating people, and that diversion from that role will be detrimental both to the universities and to the society that supports them.

Conclusions

What precedes is an attempt to describe, in very broad terms, research training and doctoral education in the United States. Although institutions vary greatly in the way that they carry out research training, certain generalisations can be made. Among them are the following:

- Admission to graduate school is competitive.
- Doctoral programmes usually have a formal component consisting of courses and seminars.
- Students must demonstrate the depth and breadth of their knowledge by passing a comprehensive examination in order to be admitted to candidacy for the PhD.
- Students must complete and defend a dissertation that demonstrates their ability to do independent work on an original and significant research topic.
- Usually, a central graduate school assures that all of these activities are carried out with high standards, with fairness to students, and with equity among departments.

Beyond this, programmes vary, among disciplines of course, but also among departments at different institutions, many of which have developed their own, often unique, approaches to graduate education and research training. These approaches may include specialisation in certain areas of research, often as a result of historical development or local opportunities, but also as a result of a certain philosophy about graduate education. This flexibility, within broad limits that assure that all students are well educated in the substance, and well trained in the practice, of their fields, has been successful in producing large numbers of scientists and scholars capable of working in a variety of settings including universities, industry, and government.

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Council of Graduate Schools Publications

The Council of Graduate Schools publishes a continuing series on various aspects of graduate education. The titles are as follows:

- *Academic Review of Graduate Programs;*
- *Doctor of Philosophy Degree;*
- *Enhancing the Minority Presence in Graduate Education;*
- *Enhancing the Minority Presence in Graduate Education II: Assessing Progress;*
- *Enhancing the Minority Presence in Graduate Education III: Institutional Partnership Programs;*
- *Enhancing the Minority Presence in Graduate Education IV: Models and Resources for Minority Student Recruitment and Retention;*
- *University Representatives for Minority Student Recruitment and Retention Directory;*
- *Essential Guide to Graduate Admissions;*
- *Graduate School and You;*
- *Graduate Student Financial Support: A Handbook for Graduate Deans, Faculty, and Administrators;*
- *Graduate Study in the United States: A Guide for Prospective International Graduate Students;*
- *International Graduate Students: A Guide for Graduate Deans, Faculty, and Administrators;*
- *Off-Campus Graduate Education;*
- *Organization and Administration of Graduate Education;*
- *Research Foundations of Graduate Education: A Five-Country Exploration;*
- *Research Student and Supervisor;*
- *The Role and Nature of the Doctoral Dissertation;*
- *Values and Ethics in the Graduate Education of Scientists.*

Chapter 8

RESEARCH TRAINING IN THE CZECH REPUBLIC

by

Dana Tollingerová, Helená Sebková and Jana Hendrichová

Introduction

Until 1989, the main form of research training at postgraduate level in the Czech Republic was the *aspirantura*, which led to the degree of candidate of sciences (CSc). It was organised both by the institutions of higher education and the Academy of Sciences, and was based on legislation developed by the Academy. The Higher Education Act (Act No. 172, 1990) made provision, within higher education, for doctoral studies leading to a doctorate which was to replace the *aspirantura*. At present, the Academy of Sciences continues to organise *aspirantura* studies, but doctoral studies are being introduced in the institutions of higher education that receive accreditation from the Accreditation Commission. *Aspirantura* studies are gradually being abolished at the institutions of higher education. Co-operation between the institutions of higher education and the institutes of the Academy to organise doctoral studies is based on contracts. These changes are occurring as the Academy of Sciences becomes smaller, and research and science are encouraged in the institutions of higher education. The financing of research and development is also changing – a system of grants is being introduced in various sectors of research and development as well as at national level.

This chapter presents the organisation of, and the laws governing, postgraduate research training in the Czech Republic with respect to the changing positions of the Academy of Sciences and the institutions of higher education. It describes the characteristics of postdoctoral studies which lead to the degree of doctor of sciences (DrSc) in certain areas, and gives information on the institutionalisation and internationalisation of research training. In addition, changes in legislation and the funding of research and development are reported. Section 2 first gives a description of the research activities of secondary students and undergraduates.

Since the present social, economic and political transformation is creating major changes in Czech society, it is expected that the organisation of research training and related legislation will continue to develop as experience evolves. The role of the institutions of higher education in this process is likely to continue to grow.

There are at present 23 institutions of higher education, with over 100 faculties, in the Czech Republic. In 1991, five new regional universities were established, with the aim of overcoming the concentration of higher education in big cities. These new universities have mostly been established in distant faculties of already existing institutions.

The system of higher education consists of eight classical multi-disciplinary universities with varying combinations of faculties of law, philosophy, teacher training, theology, mathematics and physics, natural science, medicine, etc.; one independent teacher training institute; six technical universities; one school of economics; two universities of agriculture; one university of veterinary medicine; and four academies of arts. The numbers of students and teachers in the different types of institutions of higher education are given in Tables 8.1 and 8.2.

Since the end of the 1980s, the numbers of students and teachers have remained quite stable, with minor changes connected with the transformation of the system of

Table 8.1. **Students in different types of institutions of higher education in 1991/92**[1]

	Full-time	Part-time	Postgraduate and Other Special Courses[2]
University	45 547	9 100	9 700
Technical	34 927	2 807	3 179
Economic	6 635	1 214	693
Agricultural	6 162	1 120	705
Academies of Arts	1 452	255	71
Total	94 723	14 496	14 348

1. In addition, in 1991/92, 592 students followed individually designed courses of undergraduate studies. The number of foreign students at the Czech institutions of higher education was 2 771.
2. Continuing and adult education, requalifications, etc.

Table 8.2. **Composition of teachers, 1991/92**

	Total	Professors	Associate professors	Assistants and lecturers	Internal teachers
University	6 785	532	1 599	4 654	1 392
Technical	4 068	293	1 103	2 672	517
Economic	584	52	108	424	15
Agricultural	823	90	251	482	7
Academies of arts	502	82	109	311	310
Total	12 762	1 049	3 170	8 543	2 241

Source: Higher Education Statistics, 1992.

Table 8.3 **Staff in the Academy of Sciences (FTE)**

	1989	1990	1991	1992
Numbers of research staff	7 876	7 718	6 646	5 628
Numbers of staff with scientific or research degrees	3 000	2 894	2 659	2 473

Source: *Proposal of the Transformation Project*, 1993.

higher education. For teachers, these changes are concerned with professionalisation, *i.e.* increasing the proportion of teachers with scientific and research degrees (required for positions of professor and associate professor). In 1993, the total number of students rose by about 5 per cent in comparison with previous years.

The number of institutes of the Academy of Sciences has decreased over the period 1990-93, both because of diminished Academy funding by the state budget and because of internal reorganisation. In mid-1993, the Academy had 60 institutes, specialised in the areas of life sciences, physical sciences, and social sciences, and eight other places of activity (the central administration, the publishing house, the service centre, the patent and licence centre, etc.). The evolution of Academy research staff between 1989-92 is shown in Table 8.3, and the staff was further reduced in 1993.

It is expected that, in the future, part of the Academy research staff will move to higher education. Some contracts to this end have already been concluded between institutes of the Academy and institutions of higher education, and some professionals who have left the Academy have found new jobs in higher education.

Preparation for research training: system and forms

Preparation for research training in the Czech Republic is, by tradition, long-term. Considerable attention is devoted to secondary school students who are interested in research and show intellectual promise. Much effort is made to identify and develop these talented individuals through various forms of student professional activity (*studentská odborná cinnost-SOC*), which have been in operation for more than 30 years.

Interest in research is developed through student excursions to research institutes and co-operation on research projects but mainly through professional vacation study stays at institutions of higher education in the areas of physics, meteorology, botany, protection of forests, etc.

Talents are developed at secondary schools through Olympiads: these are competitions related to knowledge gained outside the framework of secondary school studies. Olympiads are organised in the fields of mathematics, physics, biology, chemistry, geography, history, and foreign languages and take place at local, regional, national and international levels. Olympiad winners receive attractive prizes in the form of expeditions, vacation visits to research institutes abroad, etc.

Motivating students to maintain interest in research continues during undergraduate studies. For example, some students are accepted as research assistants in a department or a laboratory. They receive a small stipend for ten to twelve hours of work a week. They undertake some auxiliary but independent research work, *e.g.* in computing, recording research processes, preparing laboratory equipment, studying and taking notes in archives and/or libraries, etc. They thus develop not only professional knowledge and skills, but also assimilate characteristics of research work, such as the division of labour, communication within the research team, discipline, initiative, inquisitiveness, and skill. The percentage of these assistants at faculties varies according to the financial capacity of the institutions. On average, it is about 3 per cent of all students.

Another form of student research activity in higher education is the competition in research and development (*studentská vedecká a odborná cinnost-SVOC*). This usually takes place during the second year of undergraduate studies. Students who undertake this activity complete independent research work – under the guidance of their teachers – during one academic year. The project reflects the student's research interests or the research tasks of the department. The competition is organised at the faculty and national levels in various disciplines. The winners receive financial prizes, and may publish the results of their research. Depending on the discipline, participation in professional competitions varies between 7 per cent and 30 per cent of all students.

The third form is the competition based on undergraduate artistic activity (*zájmová umelecká cinnost-ZUC*). Students of the academies of arts as well as amateurs in interpretative or creative arts can participate in this activity.

Other opportunities for students to begin research work are provided by some international agreements and the European Union programme TEMPUS, in the form of research study visits abroad.

The reason why students often do not accept offers to participate in summer schools and research study stays abroad is that during vacations they earn money to cover expenses incurred in their studies. However, they often participate in language courses in or outside the country, or in "study visits" designed to broaden their general as well as their professional knowledge. Study stays abroad by Czech students often depend on sponsorship by an external agency or foreign stipends.

In the Czech Republic, research universities, in which research and learning are already linked at the undergraduate level, or other forms of undergraduate learning through research (as in the United States), do not exist.

Diverse forms of preparation for research training are available to higher education graduates. They fall into two groups: postgraduate studies aimed at the development of research and scientific qualification (PGS), and postgraduate studies aimed at the attainment of research degrees (PGDS). The rest of this section describes the postgraduate studies aimed at the development of research and scientific qualification (PGS). The next section will deal with the PGDS, the most important and most systematic form of research training for higher education graduates.

Courses for this type of postgraduate study may last from one semester to two years; at the end, students receive a certificate of qualification. The certificate may have local,

disciplinary, or national validity. According to the Higher Education Act, these courses are included under lifelong education. Currently, they are mainly oriented towards information and computer technology: the planning of experiments, modelling and processing of data outputs; the theory and methodology of computer graphics; and some relevant knowledge from computer science and cognitive science. In the humanities, this short cycle includes mainly epistemology, philosophy, and general linguistics; in the natural sciences, it includes statistics, theory of probability, and ecology; and in the social sciences, it includes law and economics management.

For 20 per cent of postgraduate students, postgraduate studies in a specific field are obligatory. In this respect, the courses included in the compulsory further education of medical and veterinary doctors should be mentioned. These studies form two successive cycles at the end of which participants receive "attestations" (special degrees used in the medical professions). The first attestation certificate gives doctors the right to participate professionally in research (among other things). The second attestation is an official acknowledgement of specialisation by human or veterinary doctors.

Another type of professional postgraduate studies, which leads to a certificate and includes substantial preparation for research, is the study of higher education pedagogy organised by some faculties of humanities. Attendance at these courses is not compulsory. These studies enable teacher assistants at institutions of higher education to acquire useful pedagogical skills, which include not only the ability to teach, but also ways to investigate the process of education and work with students using scientific methods. Pedagogical and psychological research is of great significance for higher education teachers, because it leads them to analyse their role and evaluate themselves.

Achieving increased research qualifications, in the absence of delivery of a certificate is possible through research study stays. Teachers may move temporarily to other institutions of higher education or research institutes in the Czech Republic or abroad. However, this opportunity has not been used satisfactorily. Teachers who graduate, go through postgraduate studies, and then work at the same institution, without knowing any other intellectual environment (so-called "home-made" teachers), are not the exception. The situation for professional study visits abroad is somewhat better. They are based on intergovernmental cultural agreements or co-operative agreements between institutions of higher education. These have developed mainly during the last three years, partly through the programme TEMPUS.

Postgraduate studies in view of a research degree

The development, since 1951, of postgraduate studies in view of a research degree is complex. These studies take three forms:

- postgraduate study leading to a doctoral degree (Dr);
- postgraduate study leading to the degree of candidate of sciences (*candidatus scientiarum*, CSc), *i.e. aspirantura*;
- research and scientific activity leading to the doctor of sciences degree (DrSc).

The doctoral degree

Postgraduate study leading to a doctoral degree (Dr) was introduced in virtue of Article 22 of the Higher Education Act and links doctoral studies with older models dating from the Middle Ages: doctoral studies were organised at Charles University in Prague, as in other European universities, from the middle of the 14th century. This legislation was complemented by a decree of the Czech Ministry of Education, Youth and Sports (Direction 1991) and by recommendations of the Czech Accreditation Commission, which evaluates the ability of institutions of higher education to offer doctoral studies; on the basis of its recommendations, the Ministry of Education empowers the institutions of higher education to organise doctoral studies and to award the title of doctor.

This degree is the highest academic degree awarded by Czech institutions of higher education and is the equivalent of the PhD. The field in which the degree is awarded is indicated on the diploma and in a review of the recipient's studies enclosed with it.

Institutions of higher education are empowered to organise doctoral studies on the basis of two criteria: the level of scientific qualification of teachers and the scientific reputation of the institution or faculty. To date, out of a total of 23 institutions of higher education, 15 (65 per cent) have been awarded the right to organise doctoral studies and to award the title of doctor in the following disciplines: humanities (theology, philosophy, history, philology, pedagogy, psychology); social sciences (sociology, politics, law, economics); natural sciences (mathematics, physics, geology, geography, chemistry, biology, ecology); engineering (technical sciences, agriculture, forestry); and arts (history of arts, theory and history of literature, history of music, aesthetics and the theory of artistic activities). Medical and veterinary sciences have only been given the right to organise doctoral studies but not to award the degree, since their graduates receive a degree of "doctor" on completion of undergraduate studies. Among the medical sciences, only pharmacology can award the doctoral degree as well.

The newly-established faculties of the new regional universities and some other new faculties, whose teaching staff is still being formed, and which mostly provide short-cycle (bachelor) studies, have not yet gained the right to award doctoral degrees.

Each group of sciences consists of fields of study and specialisations, the list of which is officially approved by the Accreditation Commission (List of Fields, 1992). From these specialisations (for an example, see Box 8.1), individual faculties derive subjects to be studied, curricula, and the examination programme, as well as the topics of dissertations. Everything else concerning the organisation and contents of doctoral studies is decided by the institutions and faculties and regulated by their statutes. Institutions and faculties differ as to the organisation of doctoral studies, owing to a lack of co-operation. Consensus has been reached, however, in certain areas.

Postgraduate doctoral study takes two forms: "internal" and "distant". Internal study is mostly earmarked for new higher education graduates and is organised as full-time study. Participants receive a stipend. Distance study is for employed applicants and is mostly independent and part-time; the students are not financially supported by the state and they, or their employers, pay a fee.

Box 8.1 **Specialisations in doctoral studies (illustrations)**

Field of Study (specialisation)

Law	Biology
Administration	Biophysics
Commercial law	Botany
Constitutional law	Ecology
History of state and international law	Genetics
Civil law	Hydrobiology
Criminal law	Immunology
Theory of state law	Microbiology
Philosophy of law	Molecular and cell biology
	Parasitology
	Physiology and developmental biology of animals
	Soil biology
	Zoology

The length of internal study is three years, while distant study may last up to seven. However, the period tends to be prolonged, as is common in all systems of higher education in Europe and the United States. Both these forms of study may be interrupted for a certain period if a serious reason is given. Results of examinations are valid for seven years, after which they must be taken again.

The academic year for postgraduate doctoral studies at most institutions of higher education is the same as that of the undergraduate academic year, even though some institutions of higher education organise intensive workshops during vacations. The terms of examinations are not set, as they are for undergraduate studies, but are organised on an *ad hoc* basis for both forms of study. In both cases, the programme is composed of three segments of unequal length: course work, the preparation of a dissertation, and the conclusion of studies.

Course work should not cover the same ground as undergraduate studies in the same field. It either leads to greater specialisation in a discipline (*e.g.* constitutional law), or to interdisciplinary specialisation (*e.g.* the economics of agriculture). The programmes of study may be individual or collective and are composed of modules, the content and sequence of which change to meet students' needs. Some of these modules offer preparation for the concluding examination, others are oriented towards the theoretical background of the dissertation (for an example of modules and standards, see Box 8.2). At some faculties, mainly in the natural and technical sciences, postgraduate study starts with the choice of the dissertation topic, and the programme of study is constructed to fit the needs of the dissertation. The humanities and the social, medical and veterinary sciences, instead, start with the theoretical background; students are expected to "find themselves", and thus their professional orientation, in these programmes.

Box 8.2 **Modules and standards in doctoral studies (illustration)**

Field of study: Linguistics

Specialisation	English Language
Modules of the study programmes	1. Introduction to general linguistics 2. Introduction to history of linguistics 3. Introduction to comparative germanic linguistics 4. Historical development of English 5. The system of contemporary English 6. Territorial differences and social stratification of English 7. Principles and methods of research on the English language
Standards in module 6	1. Diverse standards of English (British, American, Irish, Australian, Indian), their origin, dissemination and basic characteristics 2. Introduction to synchronous and diachronous English dialectology 3. English in developing countries 4. Specific forms of English (Pidgin, Creole) 5. Sociolinguistic aspects of English 6. Geographic variants of English

Students may also occasionally choose their field of doctoral study on the basis of a teacher's personality, reputation or research orientation, in order to study with an eminent teacher or scientist, or to become a member of a "school". This motivation, which is frequent in other countries, applies sporadically at the Czech institutions of higher education.

The dissertation can be presented in various forms. It must contain new information, whether the results are obtained by laboratory experimentation, by generalisation from practical experience and through measurement, by study of archival materials, or theoretically. This new information should contribute to the development of knowledge and should be objectively documented, whether statistically or otherwise. It should be compared to the state of knowledge when work on the dissertation started. It is recommended that the results of the dissertation be at least partly published or otherwise made public (*e.g.* at conferences), so that the work can be evaluated by the relevant scientific and research community. Nevertheless, given the limited opportunities for publication in the Czech Republic, this condition cannot always be fulfilled at present.

If the subject of the dissertation requires co-operation by several postgraduate students, the contribution of each must be clearly defined.

Postgraduate doctoral studies are completed by a doctoral examination (*rigorosum*) and the defence of the dissertation. The time between these two events is defined by the institution of higher education or by the faculty (it is recommended not to have both in

the same term). It is possible, at some institutions, to pass the examination just after the conclusion of course work. The advantage is that the knowledge acquired, which is part of the examination, is fresh in the students' minds. The disadvantage is that the course work is less well integrated with the dissertation. Some institutions and faculties have decided to set examinations for all courses studied before the *rigorosum*, but in this case the knowledge gained remains fragmented. Distance students prefer to have the examination and the dissertation defence close together. Most students would welcome the possibility of defending the dissertation, when they are expected to show their understanding of the theory underpinning the dissertation, before the examination. All these approaches are allowed at present.

The management of postgraduate doctoral studies is subjected to "study order" and "*rigorosum* order". Both are related to the statutes of the institution or the faculty. The lack of co-operation among the institutions of higher education and the lack of monitoring leads to differences in the philosophy and organisation of studies. This may negatively influence the evaluation of quality and the equivalency of scientific degrees.

In the management of postgraduate doctoral studies, there is first the tutor, who is a professor or associate professor in the department where the postgraduate studies are organised, or another eminent researcher with a scientific degree. Because of the level of research qualification of higher education teachers at Czech institutions, it is not always possible to ensure the presence of such a tutor.

The tutor, specialisation, curriculum, subject of dissertation, terms of examinations, and defence of dissertation, as well as the composition of the respective commissions, is approved by a field committee. This is the second step in the hierarchy of the management of postgraduate doctoral studies. This committee includes external professionals – from other institutions of higher education, research institutes, and firms. The numbers and professional qualifications of participants in the committees are fully acceptable, although they do not, as yet, have enough experience in the conception and management of postgraduate doctoral studies. At this level, minimum or maximum requirements concerning the performance of postgraduate students are imposed by the committees.

The third level of management is that of the commissions for admission, for examination, and for the defence of the dissertation. At most institutions of higher education, the admission commissions have been too liberal. Some institutions and faculties see postgraduate studies as prestigious and wish to have students at any cost. They believe that postgraduate studies contribute to their "image" and to their professional authority.

The significant differences in attitude among admission commissions are due to the overall positions of the institution or faculty on the forms of postgraduate research training, which they organised until 1990 (*aspirantura*). Some institutions moved *aspirants* to postgraduate doctoral studies by administrative *fiat*, without examining their research abilities. As a result, the "eternal" *aspirants*, who were unable to finish their studies because of lack of ability, were shifted to doctoral studies. Other institutions adopted a completely different approach: they indicated a date (generally the end of 1993) when the *aspirantura* would be cancelled, without any compensation to students who had not completed it. This administrative decision put some talented postgraduate students in a precarious situation, and they left their institutions. Yet institutions of higher education

desperately need talented young professionals. Finally, some institutions chose the most reasonable solution and allowed *aspirants* to decide whether they wanted to complete their *aspirant* studies or to be transferred – after appropriate examinations – to doctoral studies.

The highest level in management of doctoral studies is the scientific council of institutions and faculties. They award scientific degrees on the recommendation of the field committees.

According to the 1992 education statistics, there were 3 661 doctoral students at institutions of higher education in 1991/92 , of whom 1 162 were women (32 per cent). The number of accepted doctoral students almost doubled in 1992/93 compared to the previous academic year (192 per cent) (see Table 8.4). Charles University in Prague has increased the number of its postgraduate students from 110 to 568 (*i.e.* more than five times – 516 per cent), while at the smaller Palacky University in Olomouc the increase was low (115 per cent). The situation is more balanced in technical fields. The Czech Technical University has almost doubled its postgraduate students (185 per cent), as has the Technical University in Brno (179 per cent), and the Technical University in Ostrava has more than doubled (211 per cent). The numbers of postgraduate students at the University of Agriculture in Prague and Brno, as well as at the new regional universities, did not increase (with the exception of the University of West Bohemia).

Table 8.4. **Postgraduate doctoral students, 1991-92**

	1991			1992		
	F	D	Total	F	D	Total
Charles University, Prague	44	66	110	237	331	568
Masaryk University, Brno	7	213	220	106	169	275
Palacký University, Olomouc	17	30	47	15	39	54
University of South Bohemia, Ceské Budejovice	3	5	8	5	5	10
University of West Bohemia, Plzen	15	17	32	17	51	68
University of Veterinary Medicine, Brno	23	0	23	23	18	41
University of Economics, Prague	15	28	43	28	43	71
Czech Technical University, Prague	154	53	207	281	102	383
Technical University, Brno	50	118	168	76	225	301
Institute of Chemical Technology, Prague	105	66	171	143	74	217
Institute of Chemical Technology, Pardubice	0	0	0	17	19	36
Technical University, Ostrava	20	126	146	42	267	309
University of Mechanical Engineering and Textiles, Liberec	15	21	36	27	32	59
University of Agriculture, Prague	64	0	64	63	0	63
University of Agriculture, Brno	0	0	0	12	0	12
Total	532	743	1 275	1 092	1 375	1 467

F: fellowship, full-time study.
D: distant study.
Source: Materials of the Ministry of Education, 1991-92.

It is difficult to identify the reasons for this uneven development, but there are at least three interconnected factors: first, government research policy is not well formulated; second, some of the institutions of higher education do not realise the importance of doctoral studies for the renewal of their teaching staff (who are near retirement and do not have adequate scientific qualifications); and, third, institutions are unable to devote a part of their budget to the development of research training, mainly for the stipends of postgraduate students, because of their overall lack of funds. For example, students with stipends are only 44 per cent, on average, of the total number of postgraduate students. At the Czech Technical University in Prague, they are 73.4 per cent; at the University of Chemical Technology in Prague, 65.9 per cent; at the Palacky University in Olomouc, 27.8 per cent; and at the Technical University in Ostrava, only 13.6 per cent.

Even though there are not yet any graduates from postgraduate doctoral studies, it is possible to make some assumptions about the career perspectives of applicants for this degree.

In the case of past *aspirants* employed in institutions of higher education, 70 per cent are employed at the institution where they did their research training, and 30 per cent are from other institutions. This proportion is changing at present. The institutions of higher education realise that research training is almost exclusively meant to fulfil their own needs: internal postgraduate students are supposed to become teachers at their institution, and most part-time (distance) students are teachers in the same institution who do not possess the appropriate scientific qualifications. Currently, there are 5 506 teachers with unsatisfactory qualifications in the Czech institutions of higher education, about 43 per cent of the teaching staff. A comparison of this number with the number of distance postgraduate students who are teachers without a scientific degree (1 375) shows that only 25 per cent of these teachers seek higher qualifications. Current internal postgraduate students may ultimately replace 20 per cent of the teachers with incomplete qualifications, leaving no qualified replacement for the other 55 per cent. This takes no account of losses of qualified teachers owing to retirement or to moves to better-paid jobs in the private sector.

Even if all present postgraduate students finish their studies in the expected time and if the number of postgraduate students increases by about 15 per cent a year, it will not be possible to rapidly remedy the present lack of qualified teachers. Institutions of higher education will therefore have to recognise more clearly the close connection between the doctoral studies they provide and the renewal of their teaching staff. Otherwise, they will fail to overcome the long-term crisis of underqualified personnel and will have to seek new sources of scientifically-qualified professionals elsewhere, *e.g.* from the Academy of Sciences.

The candidate of sciences (CSc) (aspirantura) degree

This degree was introduced in 1950 as a result of the "unique school" concept, on the Soviet model, and was modified later, owing to some changes in legislation. Over time, the *aspirantura* moved closer to the conception of postgraduate doctoral studies in Western European universities. These studies were well respected and acknowledged as

equivalent to studies leading to a scientific degree in Western European countries until the early 1970s.

The degree is awarded by the scientific councils of the institutions of higher education and the Czech Academy of Sciences in 19 fields of study (see Table 8.5). Research training has two stages: the candidate of sciences degree (CSc) in a given discipline, followed by the doctor of sciences degree (DrSc), also in a given discipline.

To obtain the degree of candidate of sciences (CSc), it is necessary to pass examinations after completing course work and to defend a dissertation before a commission. The study programmes are modular in structure, and most of the professional courses are obligatory. Agreed professional standards determine the requirements which students must fulfil.

Aspirantura graduates have mostly been employed by the institutes of the Academy of Sciences and the institutions of higher education.

The doctor of sciences degree (DrSc)

This degree is attained after long-term research work and publication of a dissertation that contributes to the development of the area of science involved. The dissertation

Table 8.5. **Degree CSc (*candidatus scientiarum*) awarded, 1985-89**

	Number of degrees					
	1985	1986	1987	1988	1989	Total
Physics, mathematics	71	73	83	70	67	364
Geology	12	17	17	21	15	82
Geography	6	8	4	7	2	27
Chemistry	50	46	61	66	75	298
Biology	52	52	68	65	57	294
Engineering	373	403	345	317	360	1 798
Agriculture, forestry	83	102	91	91	64	431
Veterinary medicine	19	8	14	12	11	34
Medicine	163	132	114	110	139	658
Pharmacy	9	5	4	5	11	34
Philosophy	33	40	37	27	55	192
Economics	113	127	133	129	141	643
Law	26	22	24	29	27	128
History	30	36	27	43	38	174
Linguistics	17	16	8	9	13	63
Education	48	44	42	65	71	270
Psychology	9	7	12	15	12	55
Arts, music, literature	21	11	25	18	16	91
Military sciences	24	22	29	20	14	109
Total	1 159	1 171	1 138	1 119	1 188	5 775

Source: *Vestnik* (News) of the Czech Commission for Scientific Degrees, 1990

defence is, in fact, a defence of a life's work, which must be documented not only in the bibliography but also by proof of acceptance of the work by the scientific community (through citation indexes, etc.). The award of a scientific degree is made public and objections may be raised for up to three years from the time of the award.

From 1969 to 1989, 21 882 scientific degrees were awarded in the Czech Republic: 92 per cent were for candidates of sciences and 8 per cent for doctors of sciences. Roughly 1 100 candidates of sciences degrees were awarded annually, but doctor of sciences degrees were awarded more and more frequently (the number of degrees rose by 188 per cent between 1985 and 1989). Most applicants for these degrees are from institutions of higher education (over 50 per cent); the others are from the Academy of Sciences (24 per cent) and other organisations (23 per cent). The candidate of science degree was an important condition for obtaining the position of associate professor (*venium docendi*) and the doctor of sciences degree for that of professor.

At the end of the 1970s and during the 1980s, the professionalisation of teachers was interrupted by the ideological intervention of the *nomenclatura*, which imposed more study of Marxist-Leninist philosophy during the *aspirantura*, to the detriment of professional disciplines. Because of repeated testing of applicants on ideological grounds, students waited a year or more to be accepted. As a result, the age of completion of postgraduate studies rose to an average, in 1989, of 38.2 years (see Table 8.6); this is rather late to begin a professional career as a scientist.

Table 8.6. **Average age of graduates from *aspirantura* (CSc), 1985-89**

	Average age				
	1985	1986	1987	1988	1989
Physics, mathematics	36.6	35.9	36.3	34.7	35.2
Geology	34.8	37.9	36.4	38.6	35.6
Geography	38.8	40.5	39.0	43.9	31.0
Chemistry	34.9	34.1	35.0	34.7	34.0
Biology	35.7	36.2	35.9	36.6	36.1
Engineering	37.5	37.7	38.0	39.0	37.9
Agriculture, forestry	38.7	37.8	37.7	38.4	39.2
Veterinary medicine	36.3	40.5	41.0	37.4	34.9
Medicine	40.1	40.7	47.7	39.6	40.7
Pharmacy	33.8	35.8	38.5	35.6	36.6
Philosophy	42.3	40.6	38.9	41.6	43.6
Economics	38.4	40.0	40.0	40.3	39.6
Law	37.2	35.2	41.5	41.7	38.2
History	37.6	39.6	37.4	39.9	39.2
Linguistics	42.6	39.3	44.9	35.3	43.2
Education	43.9	44.4	44.6	42.1	44.5
Psychology	42.8	38.7	36.5	38.8	40.2
Arts, music, literature	38.7	41.2	40.7	40.1	36.8
Military sciences	41.4	39.5	41.6	43.5	41.6
Total average age	38.4	38.5	39.3	38.9	38.2

Source: *Vestník* (News) of the Czech Commission for Scientific Degrees, 1990.

After 1989, when this intervention ceased, the training system became once again what it had been in the 1960s and early 1970s and thus much more productive. *Aspirantura* research training is undertaken at present in some institutions of higher education and in the institutes of the Academy of Sciences.

Institutionalisation of the system of research training

A trend visible in institutions of higher education in Western Europe and the United States is the institutionalisation of research training. In the Czech Republic, this process is just beginning, and there are only a few institutes that specialise in postgraduate and doctoral studies. The first was established as a branch of the Czech Technical University: the Masaryk Institute for Advanced Studies. In 1991/92 it had 492 students, most of whom took short qualification courses.

Internationalisation of research training

In relation to the unification of Europe, several international initiatives to support the development of the system of research training in the countries of Central and Eastern Europe have recently been undertaken. The Czech Republic participates through the Centre for Higher Education Studies in the following actions:

- the preparation of an information study on the systems of research training in Europe through UNESCO;
- regional projects on the development of doctoral studies in Poland, Hungary, the Czech Republic, and the Slovak Republic through the PHARE programme (the programme of the European Union for economic and technical assistance to the countries of Central and Eastern Europe);
- the development of research training through postgraduate European studies initiated by the University of Europe in Florence and the College of Europe in Bruges;
- the Education for the New Europe project developed by representatives of the countries of the Central European Initiative (CEI), which contains, among other things, a programme for the development and support of systems of research training in Central and Eastern Europe.

Legal conditions of postgraduate studies

This section describes the legal situation of the two basic forms of research training in existence: *i)* postgraduate studies leading to the degree of doctor (Dr), established by the new Higher Education Act (Act No. 172, 1990); and *ii)* postgraduate studies leading to the degree of candidate of sciences (CSc) (*aspirantura*).

Until 1989, postgraduate study leading to a degree of candidate of sciences was regulated by several legal statutes and norms for managing research training and other forms of development for enhancing the qualifications of professionals in education and research. These statutes included the Law on Awarding Scientific Degrees and on the State Commission for Scientific Degrees (1964) and five decrees (1977) (four of which were issued by the Academy of Sciences and one by the Czech Commission for Scientific Degrees). The Czech Ministry of Education and others complemented these with a manual of explanation and instructions.

The decree of the Academy of Sciences (9 September 1977) distinguished four types of research *aspirantura*: internal, seconded, external, and *aspirantura* for professionals employed by the institution.

The legal relations between internal *aspirants* and the institution at which they studied were regulated by the Labour Code, with many exceptions determined by decree. The students were awarded a low stipend by the institution at which they studied, within the limits set by a special decree. The stipend was determined according to the length of previous employment, its compatibility with the contents of *aspirantura*, and the results of entrance examinations. The stipend was initially set for a period of six to twelve months and could be extended, depending on results. If the student was sent to *aspirantura* by another institution, the latter could contribute to the stipend, to an extent that was also limited by the decree on stipends.

Seconded *aspirants* were sent by their employing institution to the institution at which they studied, and both institutions signed a contract according to the Labour Code. In this case, the employing institution provided the students with study leave and a stipend commensurate with their average income before starting *aspirantura*. The tutorial institution was obliged, by contract, to provide the research environment and set the research topic and its length, and where necessary, to provide accommodation.

For external *aspirants*, two institutions were again involved; however, there was no legal obligation or contract between them, but only between the student and his/her employing institution. The relevant decree provided for short-term paid study leave or further unpaid study leave that might be necessary to complete the study obligations.

Students involved in *aspirantura* for professionals and employed by an institution took part in research training as a basic obligation of their work. Their work and their training are closely related.

A decree also regulated study as a preparation for research training. The stipend of students was set similarly to that of internal *aspirants* and was paid by the tutorial institution. Students who moved to the tutorial institution from another institution had to rescind their contract with the latter.

No form of *aspirantura* required the payment of a fee.

Since November 1989, in connection with the socio-political changes, the organisation of postgraduate studies has changed. Both the law and the decrees became partly obsolete at both the Academy of Sciences and higher education institutions.

The Academy of Sciences has solved the problems raised by these changes by issuing instructions, valid since February 1990, for the decrees and the Law on Awarding

Scientific Degrees, which make the legislation easier to implement. The *aspirantura* remains similar to what it was in the past, except that Marxism-Leninism and Russian language, both of which were compulsory, have now been cancelled. Other obsolete details of this legislation have not been retained or have been assimilated into the present professional and moral norms.

Internal as well as external *aspirantura* continues to exist, but the decree on stipends was amended by the Academy of Sciences, as of 1 July 1992.

Institutions of higher education have started to offer, on the basis of the Higher Education Act, postgraduate study leading to the degree of doctor (Dr). Section 1(3) of this Act states, "The institutions of higher education have the right to organise postgraduate studies and the exclusive right to award academic-scientific degrees to graduates from postgraduate studies." The Ministry of Education, Youth and Sports acts as a co-ordinator and supports the development of doctoral studies and research through funding. At the request of the Council of Higher Education Institutions (the democratic body representing the institutions of higher education and their faculties) and with the aim of attaining equivalency of postgraduate doctoral studies among different institutions of higher education, the Ministry has issued Directions for Postgraduate Studies (1991), which contain some general regulations on the organisation, financing, and completion of postgraduate studies.

More specific regulations are contained in the statutes of the institutions of higher education or their faculties. The statutes of some institutions and faculties specify in detail the organisation of postgraduate studies, including: the admission of students, form and length of studies, the composition of the examination commissions, possibilities of stipends, etc. Other faculties cite the relevant part of the Higher Education Act and, in their statutes, state briefly that more detailed decisions are made by deans, with the approval of the academic senate, or in some cases, of the scientific council.

Postgraduate doctoral study is financed by the budget of the institution (or faculty) concerned. The conditions for giving a Czech student a stipend are indicated in a 1991 decree of the Czech Ministry of Education. Foreigners may receive a stipend only if they have permission to remain in the country permanently. The conditions under which stipends will be given to Slovak citizens will be formulated by the new cultural agreement between the Czech and Slovak Republics, which is just taking shape.

The 1991 decree fixes the maximum limit of the stipend, which is awarded by the dean of faculty on the basis of the student's study and research results. The student's previous professional practice is also taken into consideration. Finally, the dean may award an extra stipend for exceptional results, the level of which is also limited, once or several times.

Under the Higher Education Act, doctoral students are equal to undergraduate students at the institution, *i.e.* they have the same rights and advantages (board, accommodation, library resources, etc.). Distance students cannot obtain material support.

The right to organise postgraduate doctoral studies is given to the institution of higher education on the basis of a recommendation by the Accreditation Commission. This right may also be cancelled on a recommendation by the Accreditation Commission.

Participants in research training organised by the institutions of higher education prior to the introduction of doctoral studies may continue *aspirant* studies under the conditions existing in the Academy of Sciences, or, if they wish, they may apply for transfer to doctoral studies.

Institutions of higher education may organise postgraduate doctoral studies in co-operation with other research and scientific institutes, on the basis of a contract. These contracts could, in the future, help to overcome the existing gap between research and science organised by the institutions of higher education and by the Academy of Sciences. In this kind of co-operation, the Academy of Sciences can often provide a very good professional environment and better technical equipment, while institutions of higher education have, according to the Higher Education Act, the exclusive right to award the degree. Moreover, the fact that postgraduate doctoral studies at institutions of higher education must receive formal accreditation may contribute to their attractiveness.

Although examples of co-operation between individual institutes of the Academy and institutions of higher education exist, the norms of this kind of co-operation have not yet been legally clarified. These students normally receive their stipend from the Academy institute. This practice is based on a temporary provision, according to which it is possible to organise within the Academy of Sciences study stays of one to three years. In terms of content, these stays are equivalent to a programme of doctoral studies, and participants obtain stipends on the basis of the 1991 decree for stipends of postgraduate doctoral students.

Present science policy in the Czech Republic

Research training is closely linked to the development of science policy, which is currently undergoing significant changes. The section of the Higher Education Act which refers to the right of institutions of higher education to organise postgraduate doctoral studies was one of the first elements of these changes. This provision was meant to contribute to redressing a situation in which most basic research and development, including its funding, was concentrated in the Academy of Sciences, and science and research was largely suppressed in institutions of higher education. (Applied research was concentrated in ministry research institutes; this area is not covered in the present study.)

The separation of research and science from the institutions of higher education had, in the past, strong political motives. The Academy of Sciences represented an important way to control the distribution of information and to concentrate research and science, as well as much research training. The limitation of research in institutions of higher education was also a result of anti-intellectual politics, which aimed to educate loyal and obedient citizens, not creative and independent professionals. The paradoxical consequence was that, although the political screening of professionals in the institutes of the Academy of Sciences was less strict than the political screening of teachers (who had a greater opportunity to influence young people), Academy professionals had easier access to research results in science and technology abroad. They also had more favourable working conditions.

While informal networks or contacts in the form of external co-operation ensured the exchange of information and knowledge between institutions of higher education and the Academy of Sciences, and while there was some professional mobility (*e.g.* postgraduates), higher education institutions suffered from the unnatural separation of research and teaching. This concerned not only research in institutes of the Academy of Sciences, but also in institutions of higher education themselves, where many researchers had no contact with students. Teachers were not motivated to develop their research interests, and opportunities for such activities were limited by enormous teaching obligations. As a result, research results were not disseminated among students and the professional image of teachers suffered; further, the Academy of Sciences and researchers in the institutions of higher education lacked the feedback that is normally gained through discussions with students.

It became clear, at the end of 1989, that this unnatural situation would have to change. One reason was the lack of funds to finance separate research and development sectors in the Academy of Sciences and in higher education. Nevertheless, it was not possible simply to add the Academy institutes, some of which are excellent research units, to the institutions of higher education or to adopt some other global administrative solution. One reason was the strong political position of the Academy as an almost independent ministry managing dozens of research institutes. Another was resistance within the institutions of higher education to closer co-operation with the institutes of the Academy, since teachers may feel threatened by an influx of Academy researchers who possess good scientific and research qualifications.

The strength of the Academy may be judged by the fact that it is still able to defend its interests, although funding from the state decreased by about 30 per cent between 1989 and 1992 and continued to decrease in 1993.

The Law on the Academy of Sciences of the Czech Republic of May 1992 has been in force since January 1993. It defines as the highest body of the Academy the Assembly of Deputies of its institutes, which was established by the former Committee of the Praesidium for Management of Workplaces of the Czechoslovak Academy of Sciences. The Assembly was established as part of the decentralisation of management of the Academy from its previous central body (Praesidium) to individual institutes. The Assembly adopted, in 1993, the statutes of the Academy.

At the beginning of 1993, the government reduced the Academy budget by about one-third. This meant not only further reductions in staff (as had occurred in the previous three years), but also a substantial reduction in the overall size of the Academy. After thorough evaluation by the Assembly and the Academy Research Council, the institutes were divided into five categories, of which only the first two have not been affected by the transformation. Those in the third group were advised to reduce staff numbers and to transform their research programme and, eventually, to offer part of their research capacity (staff, as well as equipment) to the faculties of the institutions of higher education with related research orientations. Similar recommendations were given to the fourth group of institutes, where research programmes had to be cut more drastically and where financial restrictions were harsher. The Assembly decided that the institutes of the

fifth group should be dissolved or transferred out of the Academy. The 21 institutes and other workplaces in this group were abolished by the beginning of 1993.

The transformation is expected to bring about a general change in the Academy's structure and in its institutes' work methods. The re-orientation should be towards quality of output, along the lines of state scientific and research policy, which is being elaborated. The Academy administration will continue to be rationalised.

It is expected that some Academy institutes will co-operate closely with the institutions of higher education, owing to the transfer of some of their staff or some of their workplaces to institutions of higher education. The government has earmarked a so-called transformation fund to support this process. In 1993, only part of the transformation fund was used – further mergers of Academy workplaces and research teams with institutions of higher education, which will require support by the government fund, are expected to take place.

In a sense, as only the institutions of higher education have the right to award doctoral degrees, this negatively affects the organisation of postgraduate studies within the Academy. Although the Academy continues to organise *aspirant* studies, a fact which proves its willingness and ability to pursue its own concept of postgraduate studies, problems arise owing to the lack of relevant legislation or decrees. The degree of candidate of sciences (CSc) is awarded – on the basis of an agreement with the Czech Commission for Scientific Degrees – by the Scientific Council of the Academy, which was established by the new Law on the Academy of Sciences of the Czech Republic.

Some relatively well-situated institutes of the Academy have begun to co-operate with the institutions of higher education on the organisation of research training. This co-operation is often based on a contract between the respective institution (or its faculty) and the institute of the Academy, and concerns not only graduate studies, but also mobility of professionals: researchers from the Academy teach at the institution (faculty), and teachers receive sabbatical leave to pursue research projects at Academy institute.

Very important for the development of research and science is the mode of funding. Grant funding of research and development was first introduced in the Czech Republic by the Academy of Sciences in the first half of 1990. The Academy has developed an internal grant system, which distributes part of the funds obtained from the state budget and earmarked for Academy institutes through competition. These grants are only allocated to professionals working in the Academy. This system should enable the Academy to finance the best research projects and add to its prestige. In 1991-92 this system was gradually improved. At present, it is probably among the best in the country and is respected by most Academy institutes.

One advantage of this system, as compared to past practice, is that those awarded research grants learn how to cope with the management of their budget. They may also reward the participants in their projects on the basis of their achievements and include postgraduate students in the research teams. One problem is that, given the rather small share of funds distributed through grants (20 per cent of the sum earmarked for Academy institutes in 1991), it is too bureaucratic.

Similar grant systems have been created during the last three years in different branches of the national economy, mostly by the ministries. Thus, in 1991, the Ministry of Education, Youth and Sports created grant funding of research projects on problems of education. Although this system is organisationally much simpler than that of the Academy of Sciences, it still has some organisational inefficiencies and weaknesses, which are gradually being corrected. It opens the competition to projects for all agencies and individuals.

The other possibility for grant financing of research is offered by the Fund for the Development of Higher Education. The amount earmarked for the Fund, as well as priority research topics to be financed from it, are negotiated between the Ministry of Education and the Council of Higher Education Institutions. The priorities are published and projects are evaluated on a competitive basis. Heads of projects must be from institutions of higher education, but the research teams may be composed of students and professionals from the Ministry of Education, research institutes, or other workplaces. The aim of the fund is to develop pedagogic, research, or artistic activities in institutions of higher education. The fund is supervised by a joint committee of the Ministry of Education and the Council of Higher Education Institutions.

Individual institutions of higher education have introduced their own grant systems, which take different, sometimes quite creative, forms. These systems have one uniform feature, *i.e.* like the Academy of Sciences, they devote part of the institution's budget to research and development before distributing the rest of the allocated funds. However, institutions of higher education generally complain that their funds are so low that it is very difficult to spare any for research projects. On the other hand, these systems will contribute to overcoming the separation of research and teaching within institutions of higher education, since the money distributed through grants is attractive to all professionals at the institution, who will tend to form common (interdepartmental) teams. These teams may include postgraduate students and other participants in research training, which will help the development of postgraduate studies.

It is clear that the systems of financing research and development at institutions of higher education are evolving slowly, so that it is difficult, for the time being, to evaluate them. A positive aspect of the system of grant funding is that leaders of research projects in higher education institutions may make independent decisions. As in the Academy of Sciences, this was not possible in the past.

The 1992 Law on State Support for Research Activity, and the Development of Technologies resulted in important changes in the funding of research and development at the national level. Paragraph 4 of this Law states that funding for institutions involved in the research and development of technologies in the Czech Republic is derived from the budget of the relevant central organisations. According to this Law, grant funding to finance research and development of technologies should be financed "from the budget of individual central organisations in the public sector of the Czech Republic involved in the implementation of policies in research and development of technologies", *i.e.* the situation that already exists within the Academy of Sciences and the education sector. Additional grant funding should be obtained through an independent national Grant Agency [paragraph 5(1), b], funded directly from the state budget. In this way, the law

introduces grant funding for research and development from outside the research sectors (education, Academy of Sciences, and other research institutes).

On the basis of the 1992 law, the national Grant Agency was created in the beginning of 1993 by the Czech government. The law determines the activities of the Grant Agency, which sets procedures for public competition for funding of grants and organises the evaluation of applications and the choice of projects eligible for grants.

The Government Council for Research Activity and Development of Technologies, which has also been established according to this law, is a consultative body to the Grant Agency. Besides other activities, the Council is to propose the rules for funding the Grant Agency from the state budget, supervise its budget, set priority programmes for research and technological development, and submit proposals for nomination and removal of members of the steering committee of the Grant Agency.

Another very important legal change was the shift of some competencies among individual ministries. According to the 1992 Law on Measures on the Structure of State Administration of the Czech Republic, the co-ordination of research and development in all sectors is shifted from the economic ministries and other state agencies to the Ministry of Education. The Ministry is developing at present the state scientific and research policy, together with the Government Council for Research Activity and Development of Technologies, the Council of Higher Education Institutions, the Academy of Sciences, the area of applied research, and the scientific and research community as a whole.

The above-mentionned legislation concerning the organisation and funding of research and science can be expected to contribute substantially to the development of co-operation between the Academy of Sciences and the institutions of higher education which would be acceptable for both sides as well as for the scientific community overall. The national Grant Agency is expected to improve the situation because, unlike most of the other internal grant systems, it facilitates the composition of research teams with representatives of both the Academy of Sciences and higher education institutions. The Grant Agency also supports the creation of common research workplaces, which serve not only the development of research and science, but also the education of graduate students. The shift of competencies concerning the co-ordination of research and development of technologies from other state organisations to the Ministry of Education works towards the same goal.

Conclusions

The Czech Republic devotes considerable attention to the problems of research training, as the system of research training has a long tradition. Basically, research training in the Czech Republic has the following mission:

- to support the development of research and scientific policy through the preparation of researchers and scientists qualified to address research priorities;
- to ensure the renewal of a highly-qualified body of intellectual leaders, particularly in the teaching staff at institutions of higher education;
- to contribute to the development of knowledge and practice;

- to retain the prestige of Czech science in selected fields and its link with present and future trends in world science, mainly through different national and international mobility programmes for professionals (TEMPUS, PHARE, etc.).

In 1993-94, intensive work continues on the new Higher Education Act and on legislation concerning the economic functioning of the higher education and research institutions. The new law on the Academy of Sciences is also being prepared, and its adoption, expected in 1994-95, will influence future tasks relevant to research training. The most important among them are:

- the refinement of the legal conditions necessary for the management of research training;
- the further development of a well-functioning system for financing research training from the budgets of the institutions of higher education as well as from funds or other sources and from grant systems:
- the fostering of further co-operation between institutions of higher education and institutes of the Academy of Sciences on the organisation of research training;
- the improvement of national information systems and their connection with international information databases.

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1. Unless otherwise indicated, the titles are in Czech.

Annex

RESEARCH TRAINING AND EMPLOYMENT FOR HOLDERS OF DOCTORATES IN FRANCE THE ACTIVITIES OF THE ASSOCIATION BERNARD GRÉGORY (ABG)

by

José Ezratty
Director of the Association Bernard Grégory

In the early 1970s, a groundswell in favour of creating and consolidating a sound and competitive industrial fabric brought out the need for a strong link between fundamental and applied research and innovation within enterprises. To fill the numerous public contracts for civil and military research, it was clear that many new young researchers would be required both to meet the staffing needs of higher education and research institutions and to encourage firms to hire young researchers whose scientific skills would be applied to industrial problems. It was in this context that the notion of "research training" appeared; the activities of the Association Bernard Grégory (ABG) are entirely based on this notion (Berkaloff *et al.*, 1987).

Background

If training through research is a specifically French concept, it is due in large part to the structure of higher education in France. Historically, it was the mission of the *grandes écoles* to provide firms with engineers (who generally had no research experience) while it was the task of the universities to train the small number of scientists needed to staff public research institutions and schools. Only the *École normale supérieure* brought these two types of training together, educating a tiny but prestigious group of scientists who filled positions in a broad variety of economic and governmental sectors.

It was to correct this situation that in 1975 the *allocations de recherche* (research grants) were created, which initially funded 1 500 theses a year for a two-year period. In 1981, the *conventions industrielles de formation par la recherche* (CIFRE – industrial research training agreements) were specifically designed to enable young engineers working in firms to undertake doctoral research jointly funded by government and industry.

These programmes have since grown, and today the research grants are awarded to 3 800 individuals each year for a two-year period. In certain fields and for certain research subjects, an additional six to twelve months of funding can be obtained if the research is shown to be progressing satisfactorily. Some 600 CIFRE are awarded every year for a period of three years. These types of funding concern short theses, known as the third-cycle doctorate, corresponding to a university programme of three years after the master's degree. They comprise an initial year of introduction to research, culminating in the *diplôme d'études approfondies* (DEA), followed by another two years funded by the research grants, leading to the defence of the doctoral thesis. Since 1984 the different thesis programmes (third-cycle doctorate, doctorate in engineering, and state doctorate) have been replaced by a single doctorate which is generally prepared over a three-year period after receiving the DEA.

The abolition of the state doctorate was criticised, but the length of time it could involve often ruled out a post in industry for those who did not enter teaching or research. It was because of this difficulty that the first "employment exchanges" (*bourses de l'emploi*) were initially created within the French Atomic Energy Commissariat, an initiative which would later be combined with other similar ones.

The Atomic Energy Commissariat (CEA), a public research agency with a strong industrial orientation, had not only brought together after World War II an elite group of engineers who wished to take up the challenge of nuclear energy, but also an elite group of researchers who found, in this new and innovative institution, exceptionally fertile ground for continuing the research which had enabled British and American laboratories to develop radar and the atomic bomb during the war. The CEA offered the first courses in modern physics (nuclear, *quantum*, etc.) in France. This explains why the CEA set up its own system of funding state doctorates, which was to play a major role in training the entire profession (by the late 1960s, the majority of physicists received their training within this programme).

The origin of the Association

In the early 1970s, as jobs became scarce in the CEA and in the research institutes and universities which had hired intensively over the previous decade, the CEA decided to reorient its research training policies. It was still necessary to admit and train young scientists in laboratories and to preserve the vitality of research, but it was impossible to offer them career prospects after they completed their thesis. Consequently, the CEA established an "employment exchange" aimed at making it easier for them to find a job corresponding to their level of skills and qualifications and their scientific background. At the same time, the French Physics Society (SFP) was also becoming aware of the problems of young physicists in finding employment, and set up a similar initiative in Grenoble.

There was great concern among authorities within the CEA and elsewhere that there would be a growing mass of unemployed scientists, and there was in fact a serious crisis in scientific jobs in the late 1970s. The goal of those who took the lead in promoting this initiative was above all to unblock the labour market by making this pool of scientific skills available to the economic sector in a way that would be mutually advantageous.

Nevertheless, obstacles of all sorts were encountered. First, there was the reticence of young researchers, who felt that there were no worthwhile prospects outside their home laboratories and preferred stopgap solutions, even if they were painful and illusory, to switching to a market sector that in their view was at best uneducated and at worst immoral. Within firms, the prejudices were

just as strong. Why hire young people who knew nothing of industry, perfectionists with pretentious diplomas when, with six months' training, any engineer could learn as much?

It was at this juncture that the absence of scientists at the highest levels of industry – a situation very different from that prevailing in Germany or the United States – proved damaging. Even in the chemicals sector where, following the German example, doctorates had been valued, applications from young doctoral candidates were given little consideration. And among holders of doctorates, preference was invariably given to engineers, regardless of the school they had attended, over university-trained candidates, solely on the basis of their *curriculum vitae*, before an interview had taken place or the scientific content of doctoral work investigated. Such were the difficulties faced by the employment exchanges which were set up following the model of the CEA from 1973 onwards in Grenoble, Orsay, Strasbourg, Lille, Marseilles, etc., with the energetic support of the State Secretariat for Research and the General Delegation for Scientific and Technical Research (DGRST).

The job market for scientists was undergoing a crisis, even though the overall employment market for graduates was on the whole very favourable. In June 1980, a number of those involved in the employment exchanges mentioned above decided to set up a non-profit association in order to carry on the work of the small centre that Bernard Grégory had established in 1976 within the DGRST, and to name it after this eminent scientist whose life had been cut short.

This association for helping young scientists to find jobs, which is funded by four ministries (Research, Higher Education, Industry, and Labour), was designed to bring together, under their supervision, the efforts of various scientific communities, educators and businessmen who wished to provide help, as well as young scientists themselves.

How the Bernard Grégory Association works

There are many reasons for the Association's success. First, there was the moral and financial support of government. This made it possible at the outset to hire a small, independent and highly-professional team which could back up the invaluable contributions of volunteers. The Association also set up two conveniently-located centres in Paris and Grenoble.

The major contribution of laboratory heads must be mentioned next. The time when they were indifferent to the professional future of doctoral candidates is a thing of the past, and it is far less common to hear remarks such as, "Their future is no concern of mine, and I told them so when they got here," or, "In any case, if they are in my laboratory, it means that they are good and they will have no problem finding a job on their own."

Thus it has been possible to establish a network of correspondents and regional centres based in universities, engineering schools and public research institutes. Today, there are over 100 educational and training institutions and some 400 teacher-researchers in this network, which reflects the diversity of the French research and higher education system, for it includes such different institutions as the CEA, the Central Laboratory of the *Ponts et Chaussées*, the *École des mines* in Paris, the Pasteur Institute, the *Établissement technique central de l'armement* and the University of Orsay. The teacher-researcher correspondents generally rely on the information and counselling facilities of higher education institutions in setting up the Association's local centres, known as "employment exchanges".

These employment exchanges are in direct personal contact with young doctoral candidates and provide them with the advice and documentation that they need when looking for a job. They establish and monitor a job file for each applicant; this is forwarded to the central office of ABG,

which sees that it is circulated nationwide by a variety of means (publication of listings of candidates for specific scientific fields and a computerised databank).

Another decisive factor in the success of ABG was the reconciliation of public research and business in the early 1980s. The support provided by the public employment organisations, the ANPE (National Employment Agency) and APEC (National Association for Employment of Executives) should also be mentioned. They understood the specific function of ABG and recognised it as a helpful component in the effort to combat unemployment. ABG also relies on the scientific community as a whole through learned societies and associations of young researchers, which have done much to help research training gain recognition. Furthermore, a welcome development has been the considerable expansion of research in the *grandes écoles*, which has invalidated the conclusions of a well-known report of 1983 stating that they were very deficient in this area.

Finally, attention should be drawn to the interest that companies have shown in ABG. Many of them regularly consult its lists of job seekers and use its services; some of them have joined the Association. Their membership means that they find it helpful to have an interface with scientific training centres and that they share the concept of research training upon which the ABG is based. Moreover, through their yearly dues they make a significant contribution to its funding. These members make up ABG's Committee of Industrial Users, and some 50 industrial managers meet three or four times a year, by turns in different companies, and compare their various scientific hiring policies for scientists (recruitment, career management).

ABG operates by providing free of charge to enterprises lists of the young scientists who have signed up, also at no cost, at one of the employment exchanges in order to obtain help in finding a job. ABG gathers and presents in a single format a great deal of information about the scientific work of the candidates and their qualifications, and makes this information available to the personnel department of enterprises and their scientific management. All candidates are required to be sponsored by a teacher-researcher who provides references.

Today, with some 1 000 candidates enrolled from various backgrounds and all scientific disciplines and very full information on their qualifications, ABG is certainly one of the most reliable sources for those who wish to employ scientists. ABG's effectiveness can be judged from year to year by comparing the number of candidates enrolled with the numbers who find jobs (see Table below), gauging the level of these jobs by the salaries offered. The number of jobs offered to candidates by enterprises has risen steadily (from 50 per cent in 1981 to 70 per cent in 1991); there has also been – and this is valuable information – some narrowing of the gap between men's and women's salaries (30 per cent in 1986, as compared to 5 per cent in 1992). Similarly, the salaries of

Openings in industry for AGB candidates

Year	New candidates	Openings in industry[1] (%)
1986	497	60
1987	527	65
1988	571	68
1989	687	66
1990	599	71
1991	642	68
1992	734	63

1. This percentage is based on the total number of candidates leaving the Association with a job. Temporary positions, such as post-doctoral training programmes, were not counted, nor were candidates for whom there was no information.

young scientists trained in universities and in the *grandes écoles* are tending to come into line, as are those of specialists in different scientific disciplines.

ABG regularly publishes these figures in a quarterly bulletin (*Formation par la recherche*) which for the past ten years has presented public and private laboratories, enterprises, career profiles, interesting experiments in France or abroad, and statistics, notably from the Ministry for Research and Higher Education. ABG's statistics and surveys are frequently cited by the press and, although they are not as well-known as the twice-yearly APEC report on employment market trends for executives, its annual statistics are widely reported. This bulletin, which is sent free of charge to over 12 000 readers in France and abroad, has contributed greatly to making ABG better known and to promoting training research. The bulletin also maintains ties with former candidates of the Association, many of whom ask to receive it, and this enables ABG to maintain valuable contacts with young people who have been trained through research and are currently working, in key posts, in industry.

Studies carried out by the Association

ABG has taken part in sectoral surveys conducted jointly with the Ministry of Research, CEREQ (the Centre for Study and Research on Qualifications), APEC, and learned societies, on the professional future of young doctoral level scientists (physics, life and health sciences, human and social sciences).

By creating a Committee on Job Trends and Opportunities, ABG was able to extend and refine its studies through broad consultations with people concerned with all aspects of the employment of scientists. In co-operation especially with learned societies, the Committee has reviewed the situation in the Earth sciences, mathematics, electrical engineering, the physical sciences, life and health sciences, and the human and social sciences. The results of these studies are systematically published in the bulletin.

European initiatives

At the European level, the Association has tried to promote the development of similar programmes aimed at helping young scientists in other countries. One result has been a regional centre in Belgium set up by a professor at the Free University of Brussels (ULB). A network is currently being formed, tailored to circumstances in the country; other centres have been established in Ghent, Liege and Mons. The Belgian programme is financially independent.

In Great Britain, there is a similar programme, the Central Services Unit, established in 1972 in Manchester, which co-ordinates and supports the work of the job counsellors found in all institutions of higher education. It provides a full range of services for referring young graduates to employers. ABG has not established a partnership with the Central Services Unit, which has no direct government support and charges employers for its services; it would difficult to reconcile the two methods of operation.

Together with Germany and Belgium, ABG is proposing to list applicants in chemistry and physics in a shared data bank, via German, Belgian and French learned societies. This project, which will require assistance from the European Commission, will probably only be fully implemented after the current economic crisis has ended.

The international mobility of French postdoctoral researchers

The second aspect of ABG's work outside France has been setting up a system to help young French scientists carrying out doctoral or postdoctoral studies in foreign laboratories to return to France. In 1987 a CNRS report (Martin-Rovet, 1987) stressed the difficulties that these young and often brilliant scientists encounter in finding work, from abroad, in the public or private sector in France.

This led ABG to take a first step aimed at assisting these young scientists to return to France, in co-operation with the *Association pour la valorisation des relations internationales scientifiques et techniques* (AVRIST – Association for the development of scientific and technical international relations). In order to emphasise their qualifications and take account of their particular situation, ABG publishes lists of these candidates separately. As a rule, the policy is to handle these files independently from those of other candidates.

To extend ABG's international databank still further, for the last four years the Association has contributed to the initiative of the French Scientific Mission attached to the French Embassy in Washington, which organises fora in the United States to allow French public and private employers to meet some 1 000 young French researchers living abroad. The Association encourages its industrial members to attend these US Fora.

In summer 1992, a report on the international mobility of French postdoctoral researchers, drafted by a working group chaired by Mr. Claude Fréjacques, Vice-President of the French Academy of Sciences, was presented to the Minister for Research, (Fréjacques, 1992). This report makes it possible to see the scale of postdoctoral training for young French researchers and to evaluate the impact that Community programmes will have on their numbers. It recommends some improvements in problem areas. The ABG was mentioned as having a role to play in helping young French postdoctoral researchers to return to France.

It is difficult to say exactly how many young doctorates go abroad; the report estimates the number at around 400 a year but admits that this figure is probably low. This uncertainty is partly due to the diversity of funding schemes for postdoctoral training. The *Association nationale des docteurs ès sciences* (ANDES) lists over 100 of these in its guide (1993) to financial aid for doctoral and postdoctoral programmes. In the life and health sciences, one out of five doctorate holders pursues postdoctoral training. This allows them to complete work on their thesis subject, which is generally more extensive than in other disciplines, but it may also be a fallback solution in a difficult job market.

A well-rounded scientific background gives candidates a better chance of being hired by the CNRS or the INSERM (National Institute of Science and Medical Research). Pharmaceutical companies also tend to favour candidates who have done advanced research combined with substantial experience abroad.

In general, enterprises hire very few candidates with postdoctoral experience, and they usually do so because they wish to develop a new area of research, need to incorporate a specific technology without delay, or because they place value on the mobility the candidate has demonstrated.

Given the importance that other countries in Europe and North America place on postdoctoral training, which makes it possible to multiply exchanges among laboratories and to maintain worldwide scientific networks, it is clear that the recommendations of the Fréjacques Report lie in the direction of a true postdoctoral policy in France.

In keeping with its mission, ABG decided to set up a Postdoctoral Training Committee, which brings together the institutions involved in sending postdoctoral students abroad, in

order to facilitate their return to France. The Committee (known as Ulysses), chaired by Mr. Édouard Brézin, President of the CNRS, has already met twice in 1993 and has focused upon two initiatives.

The first is the promotion of the electronic message service "FROGJOBS" aimed at providing young people with information on public and private job openings. This is the fourth electronic message service set up by the French Scientific Mission in the United States. The following are already in service:

- FROGNET (a daily review of the French press, 1 000 subscribers);
- FROGTALK (open communication, 300 subscribers);
- FROGPROF (message service for teachers of French in the United States).

All these services have proved very popular among the French scientific community in the United States, and with researchers living in other countries (Israel, the Netherlands, Canada, etc.), as well as people interested in French language and culture in general.

FROGJOBS is an important part of this system, as it provides information on job market trends in France, practical advice and, most important, job offers (jobs in enterprises, notices of competitive examinations for positions in public research and higher education, job openings in the laboratories of institutions, universities and schools).

The other initiative is to make university authorities aware of the special situation of young French postdoctoral students abroad owing to their distance from France. Regarding competitive examinations for entry into universities, schools and public research organisations, whose procedures (obtaining information and application deadlines, in particular) tend to place young French scientists abroad at a disadvantage, ABG has already received the support of the Research Commission of the Conference of University Presidents. The chairman of this Commission would like to see a system that would encourage mobility and would not compel young people to stay at home out of fear of missing opportunities.

· Prospects

Has the concept of "research training" been eroded by the economic crisis of the past two years? For ABG, the answer is both disappointing and encouraging:

- disappointing, because recruitment of young holders of doctorates by enterprises has declined significantly, while job-seekers are increasing in all disciplines;
- encouraging, because the best candidates are faring far better in this crisis than in the 1970s;
- disappointing, because it takes candidates longer and longer to find jobs;
- encouraging, because salaries are not declining substantially.

This shows that enterprises, which have become highly selective in recruiting, still hire young scientists, if only to preserve research capacities that it would be unwise to abandon altogether. Although this situation shows the value of training through research, it also leads ABG to question what its future strategy should be.

First, it must reach more small and medium-sized enterprises, which individually offer a limited number of jobs but represent a sizeable figure when taken together. This is a major task given that these enterprises are widely scattered and that ABG is not accustomed to working with them as it traditionally deals with firms which are international in scope.

Second, ABG must continue to help young scientists abroad to return to France; because it is in the national interest; because enterprises have by no means lost interest in such highly-specialised and mobile candidates; and because more and more young people wish to study abroad and find attractive funding which allows them to do so. Training abroad represents a major trend that will continue to grow in the future.

It is not the role of ABG to define scientific employment policies, even though it is regularly asked to participate in debates in this area. It is and intends to remain at the service of the scientific community to help solve specific employment problems. The large increase in the number of young doctors of science (the government doubled its funding of doctorates between 1988 and 1992), and the economic crisis which leads students to prolong their higher education, make its activities all the more necessary. Provided that its resources are not affected by economic difficulties, ABG hopes to continue its work and to maintain the position it has attained as a public employment service.

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